mercruiser

SERVICE MANUAL

Number 18

MARINE ENGINES

GM V-6 262 CID (4.3L)

Balance Shaft
Including Gen+ Engines

Printed in U.S.A.

©1996, Mercury Marine

90-823226--1 996

Notice

Throughout this publication, “Dangers,” “Warnings” and “Cautions” are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. Observe them carefully!

These “Safety Alerts” alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus “common sense” operation, are major accident prevention measures.

⚠ DANGER

DANGER - Immediate hazards which will result in severe personal injury or death.

⚠ WARNING

WARNING - Hazards or unsafe practices which could result in severe personal injury or death.

⚠ CAUTION

CAUTION - Hazards or unsafe practices which could result in minor personal injury or product or property damage.

Notice to Users of This Manual

This service manual has been written and published by the service department of Mercury Marine to aid our dealers, mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures of these products, of like or similar products manufactured and marketed by Mercury Marine, and that they have been trained in the recommended servicing procedures for these products which include the use of mechanic’s common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the product’s safety will be endangered by the service procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at time of publication.

It should be kept in mind, while working on the product, that the electrical system and ignition system are capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note that, during any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed, whether metric or customary. Numbers on the heads of the metric bolts and on surfaces of metric nuts indicate their strength. Customary bolts use radial lines for this purpose, while most customary nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possible personal injury. Therefore, fasteners removed should be saved for re-use in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that meets the same specifications as the original.

Engine Mechanical Components

Many of the engine mechanical components are designed for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and wide-open-throttle operation and, therefore, require heavy-duty components. Special marine engine parts have design and manufacturing specifications which are required to provide long life and dependable performance. Marine engine parts also must be able to resist the corrosive action of salt or brackish water that will rust or corrode standard automotive parts within a short period of time.

Failure to use recommended Quicksilver service replacement parts can result in poor engine performance and/or durability, rapid corrosion of parts subjected to salt water and possibly complete failure of the engine.

Use of parts other than recommended service replacement parts, will void the warranty on those parts which are damaged as a result of the use of other than recommended replacement parts.

Replacement Parts

⚠ WARNING

Electrical, ignition and fuel system components on MerCruiser Engines and Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

V-6 Models Covered in This Manual

Model	Serial Number	Model Year
MCM 4.3L Alpha	OF000615 - OF800000	1993 - 1996
MCM 4.3LX Alpha	OF001220 - OF800000	
MCM 4.3LX Gen+ Alpha	OF803000 and Above	1996 and Above
MCM 4.3LXH Gen+ Alpha	OF803114 and Above	
MCM 262 Magnum EFI Gen + Alpha	OF803800 and Above	
MCM 4.3LX Bravo	OF 605305 - OF800000	1996
MCM 4.3LX Gen+ Bravo	OF831000 and Above	1996 and Above
MCM 4.3LXH Gen+ Bravo	OF803400 and Above	
MCM 262 Magnum EFI Gen+ Bravo	OF803802 and Above	

Service Manual Outline

SECTION 1 - Important Information

A - General Information

B - Maintenance

C - Troubleshooting

SECTION 2 - Removal and Installation

A - MCM Models - Alpha Drives

A - MCM Models - Bravo Drives

SECTION 3 - Engine

A - 262 CID / 4.3L

SECTION 4 - Electrical Systems

A - Starting System

B - Ignition System

C - Charging System

D - Instrumentation

E - Wiring Diagrams

SECTION 5 - Fuel System

A - Fuel Delivery System

B - MerCarb 2 Barrel Carburetor

C - Weber 4 Barrel Carburetor

D - Electronic Fuel Injection (Throttle Body)

A - BSO / SAV Emission

SECTION 6 - Cooling System

A - Seawater Cooled Models

B - Closed Cooled Models

SECTION 7 - Exhaust System

A - General

B - Manifold and Elbows

C - Risers

D - Collectors

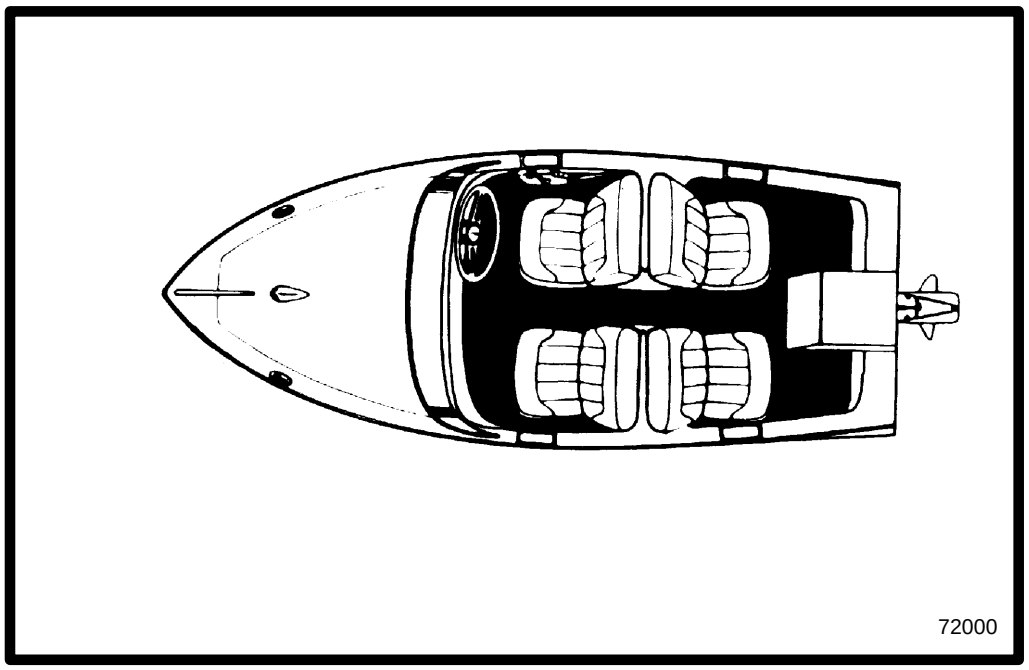
SECTION 8 - Power Steering

A - Pump

IMPORTANT INFORMATION

1

A



GENERAL INFORMATION

Index

Table of Contents

	Page
Introduction	1A-1
How to Use This Manual	1A-1
Page Numbering	1A-1
How To Read Parts Manual	1A-2
Directional References	1A-3
Engine Rotation	1A-3
Engine Serial Number Locations	1A-3
Propeller Information	1A-3
Water Testing New Engines	1A-4
Boat and Engine Performance	1A-4
Boat Bottom	1A-4
Marine Fouling	1A-5
Weight Distribution	1A-6
Water in Boat	1A-6
Elevation and Climate	1A-6

Index

Introduction

This comprehensive overhaul and repair manual is designed as a service guide for the models previously listed. It provides specific information, including procedures for disassembly, inspection, assembly and adjustment to enable dealers and service mechanics to repair and tune these engines.

Before attempting repairs or tune-up, it is suggested that the procedure first be read through to gain knowledge of the methods and tools used and the cautions and warnings required for safety.

How to Use This Manual

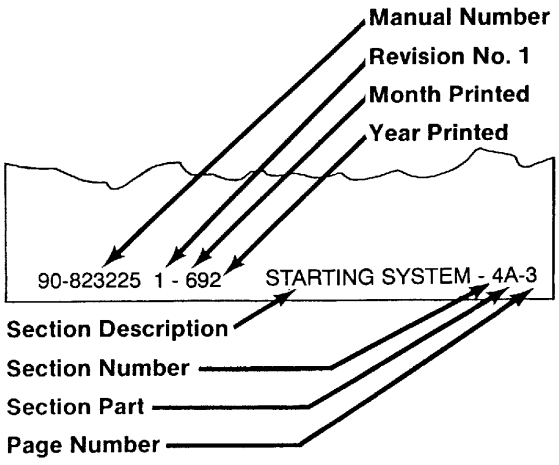
This manual is divided into sections which represent major components and systems.

Some sections are further divided into parts which more fully describe the component.

Sections and section parts are listed on the “Service Manual Outline” page following “V-8 Models Covered in This Manual” page.

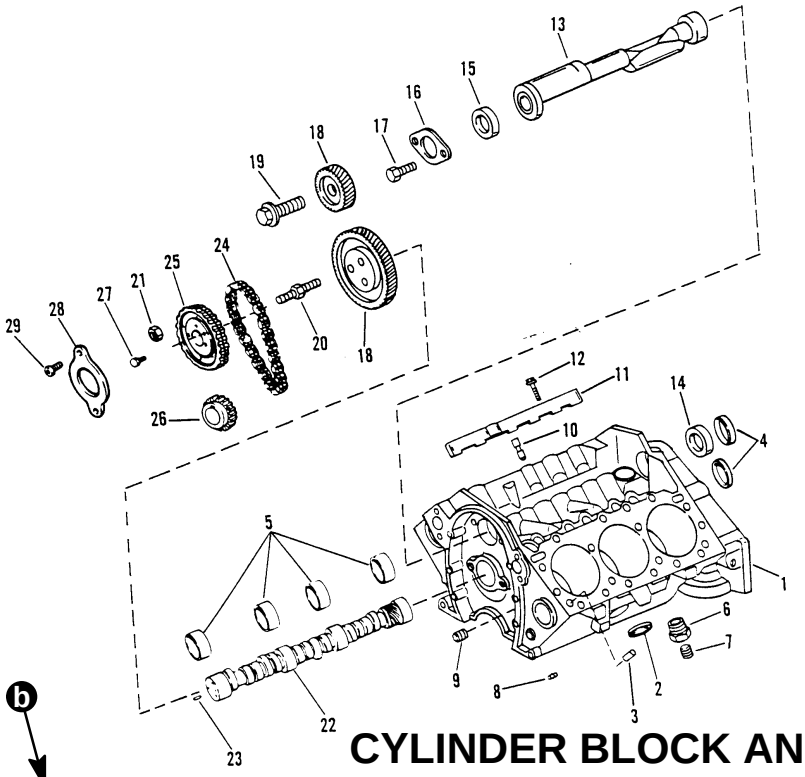
Page Numbering

Two number groups appear at the bottom of each page. Following is an example and description.



72426

How To Read Parts Manual



CYLINDER BLOCK AND CAMSHAFT

a PART NO.	b REF. NO.	c DESCRIPTION	d QUAN.
841-824146	1	CYLINDER BLOCK (See Note)	1
19-34270	2	EXPANSION PLUG	8
17-35465	3	DOWEL PIN	4
22-72640	4	EXPANSION PLUG	2
23-85674	5	BEARING UNIT (SET)	1
22-48556	6	BUSHING	2
22-32802	7	PIPE PLUG	1
22-42796	8	BY-PASS VALVE	1
19-816565	9	PLUG	1
811844	10	LIFTER	12
824331	11	RETAINER	2
10-824332	12	SCREW	4
824148	13	BALANCED SHAFT	1
31-824150	14	BEARING (REAR)	1

e NOTE: 841-824146 Cylinder Block includes only standard pistons, piston rings, crankshaft bearings and camshaft bearings.

A. **Part Number:** For part ordering - Note N.S.S. for Reference Numbers, (not shown above) - means Not Sold Separately by Mercury Marine, however, in some cases, the G.M. Part Number (for the item) is given in the Description Column.

B. **Reference Number:** For part Shown on exploded parts view.

C. **Description:** This is the most important column because it gives:
1) Description of Part: Ref. No. 1 is a Cylinder Block Assembly, No. 13 is the Balanced Shaft, etc.
2) What parts are included with a certain part: Notice how the Description of Part, for Ref. Nos. 1, and 10 through 13, are at the left side of the column. Description of Part for Ref. Nos. 2 thru 9 are indented under “Cylinder Block”. If Ref. No. 1 (Cylinder Block) was ordered, all indented parts (Ref. Nos. 2 thru 9) would come with the part. Ref. Nos. 10 thru 14 would not come with Ref. No. 1 and would have to be ordered separately. If 2 Cylinder Blocks were listed, both cylinder blocks would come with the indented parts. In some cases, an indented part will have another part indented under it. The second indented part will come with the first indented part.
3) Serial number break: If serial number information is listed, check product serial number to ensure that correct part is ordered.
4) Special information: Many times special information will be shown after description such as; L.H. Rotation, R. H. Rotation, Filter up, Filter Down, etc. This will help in selecting the correct part.

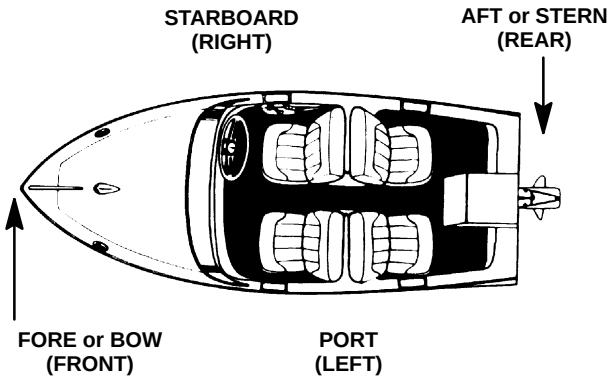
D. **Quantity:** Quantity that has to be ordered.

E. **Special Information Block:** Additional information, part numbers for gasket sets, etc.

Index

Directional References

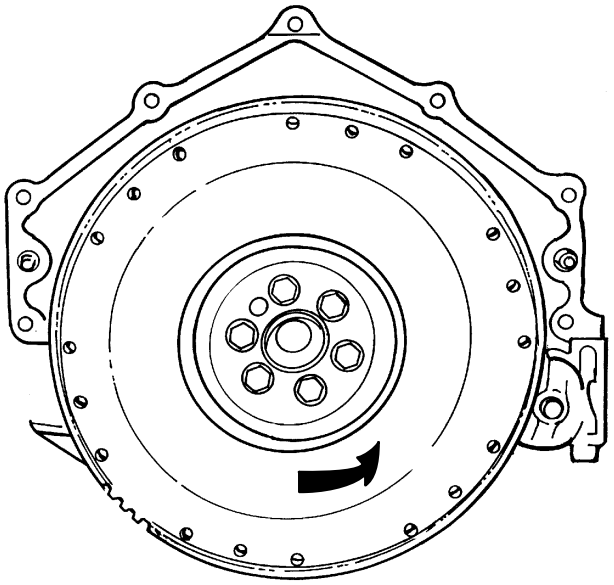
Front of boat is bow; rear is stern. Starboard side is right side; port side is left side. In this maintenance manual, all directional references are given as they appear when viewing boat from stern looking toward bow.



72000

Engine Rotation

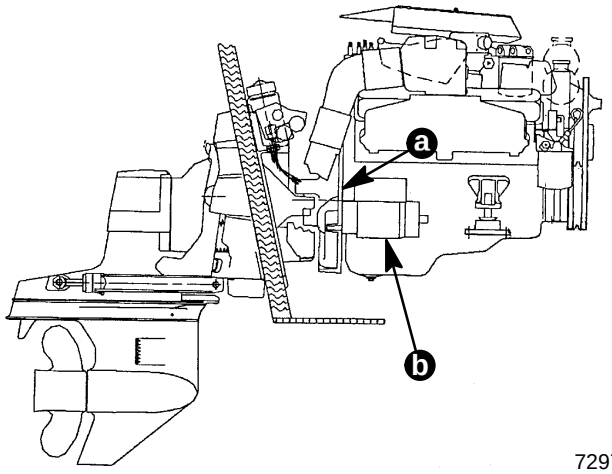
Engine rotation is determined by observing flywheel rotation from the rear (stern end) of the engine looking forward (toward water pump end). Propeller rotation is not necessarily the same as engine rotation. When ordering replacement engine, short blocks or parts for engine, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



72001

Standard Left Hand Rotation

Engine Serial Number Locations



72975

a - Serial Number Plate
b - Starter Motor

Propeller Information

Refer to the “Propeller” section in appropriate MerCruiser Stern Drive Service Manual, or order publication 90-86144, “What You Should Know About Quicksilver Propellers.”

Changing diameter, pitch or coupling of a propeller will affect engine RPM and boat performance . The blade configuration also will affect performance. Two like propellers, same pitch and diameter, from two different manufacturers also will perform differently.

It is the responsibility of the boat manufacturer and/or selling dealer to equip the boat with the correct propeller to allow the engine to operate within its specified RPM range at wide-open-throttle (W.O.T.).

Because of the many variables of boat design and operation, only testing will determine the best propeller for the particular application.

To test for correct propeller, operate boat (with an average load onboard) at W.O.T. and check RPM with an accurate tachometer. Engine RPM should be near top of the specified range so that, under heavy load, engine speed will not fall below specifications.

If engine exceeds the specified RPM, an increase in pitch and/or diameter is required.

If engine is below rated RPM, a decrease in pitch and/or diameter is required.

Normally, a change of approximately 300 to 500 RPM will be achieved for each single pitch change of a propeller.

Index

⚠CAUTION

If a propeller is installed that does not allow engine RPM to reach the specified full-throttle RPM range, the engine will "labor" and will not produce full power. Operation under this condition will cause excessive fuel consumption, engine overheating and possible piston damage (due to detonation). On the other hand, installation of a propeller, that allows engine to run above the specified RPM limit, will cause excessive wear on internal engine parts which will lead to premature engine failure.

Water Testing New Engines

Use care during the first 20 hours of operation on new MerCruiser engines or possible engine failure may occur. If a new engine has to be water-tested at full throttle before the break-in period is complete, follow this procedure.

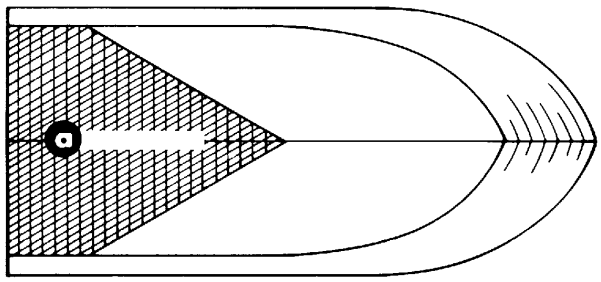
1. Start engine and run at idle RPM until normal operating temperature is reached.
2. Run boat up on plane.
3. Advance engine RPM (in 200 RPM increments) until engine reaches its maximum rated RPM.

IMPORTANT: Do not run at maximum RPM for more than 2 minutes.

Boat and Engine Performance

Boat Bottom

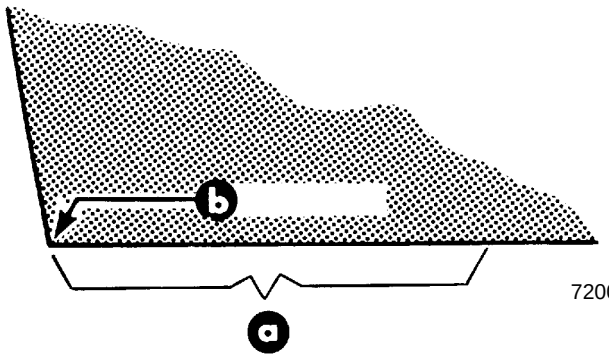
For maximum speed, a boat bottom should be as flat as possible in a fore-aft direction (longitudinally) for approximately the last 5 ft. (1.5 m).



72002

a - Critical Bottom Area

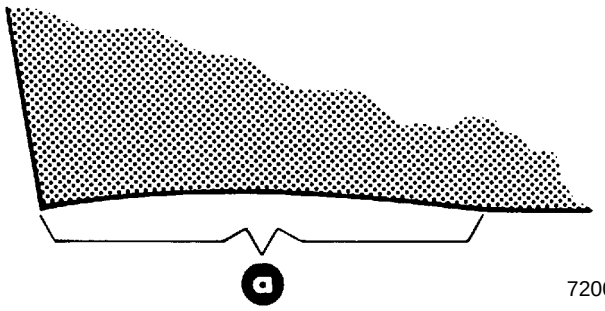
For best speed and minimum spray, the corner between the bottom and the transom should be sharp.



72003

a - Flat
b - Sharp Corner

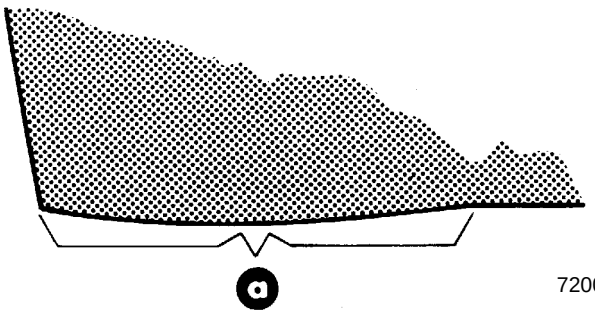
The bottom is referred to as having a "hook" if it is concave in the fore-and-aft direction. A hook causes more lift on the bottom near the transom and forces the bow to drop. This increases wetted surface and reduces boat speed. A hook, however, aids in planing and reduces any porpoising (rhythmical bouncing) tendency. A slight hook is often built in by the manufacturer. A hook also can be caused by incorrect trailering or storing the boat with support directly under the transom.



72004

a - Hook

A "rocker" is the reverse of a hook. The bottom is convex or bulged in the fore-and-aft direction. It can cause the boat to porpoise.



72005

a - Rocker

Any hook, rocker or surface roughness on the bottom, particularly in the all-important center-aft portion will have a negative effect on speed, often several miles per hour on a fast boat.

Marine Fouling

Fouling is an unwanted build-up (usually animal-vegetable-derived) occurring on the boat's bottom and drive unit. Fouling adds up to drag, which reduces boat performance. In fresh water, fouling results from dirt, vegetable matter, algae or slime, chemicals, minerals and other pollutants. In salt water, barnacles, moss and other marine growth often produce dramatic build-up of material quickly. Therefore, it is important to keep the hull as clean as possible in all water conditions to maximize boat performance.

Antifouling paint, if required, may be applied to boat hull observing the following precautions.

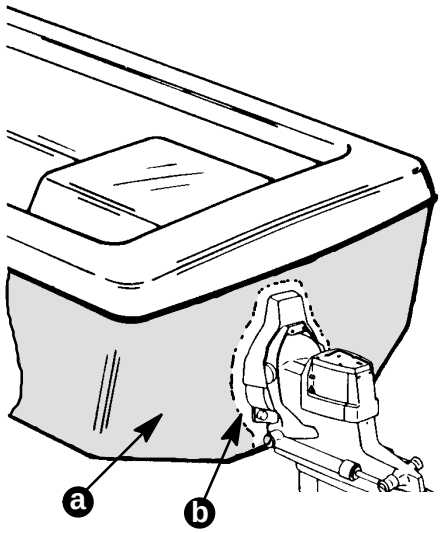
IMPORTANT: DO NOT paint anodes or MerCathode System reference electrode and anode, as this will render them ineffective as galvanic corrosion inhibitors.

⚠ CAUTION

Avoid corrosion damage. Do not apply antifouling paint to MerCruiser drive unit or transom assembly.

IMPORTANT: If antifouling protection is required, Tri-Butyl-Tin-Adipate (TBTA) base antifouling paints are recommended on MerCruiser boating applications. In areas where Tri-Butyl-Tin-Adipate base paints are prohibited by law, copper base paints can be used on boat hull and boat transom. Corrosion damage that results from the improper application of antifouling paint will not be covered by the limited warranty. Observe the following:

Avoid an electrical interconnection between the MerCruiser Product, Anodic Blocks, or MerCathode System and the paint by allowing a minimum of 1 in. (26mm) UNPAINTED area on transom of the boat around these items.



71176

a - Anti-Fouling Paint
b - Minimum 1 inch (26 mm) UNPAINTED Area

Weight Distribution

Weight distribution is extremely important; it affects a boat's running angle or attitude. For best top speed, all movable weight - cargo and passengers - should be as far aft as possible to allow the bow to come up to a more efficient angle (3 to 5 degrees). On the negative side of this approach is the problem that, as weight is moved aft, some boats will begin an unacceptable porpoise.

Secondly, as weight is moved aft, getting on plane becomes more difficult.

Finally, the ride in choppy water becomes more uncomfortable as the weight goes aft. With these factors in mind, each boater should seek out what weight locations best suit his/her needs.

Weight and passenger loading placed well forward increases the "wetted area" of the boat bottom and, in some cases, virtually destroys the good performance and handling characteristics of the boat. Operation in this configuration can produce an extremely wet ride, from wind-blown spray, and could even be unsafe in certain weather conditions or where bow steering may occur.

Weight distribution is not confined strictly to fore and aft locations, but also applies to lateral weight distribution. Uneven weight concentration to port or starboard of the longitudinal centerline can produce a severe listing attitude that can adversely affect the boat's performance, handling ability and riding comfort. In extreme rough water conditions, the safety of the boat and passengers may be in jeopardy.

Water in Boat

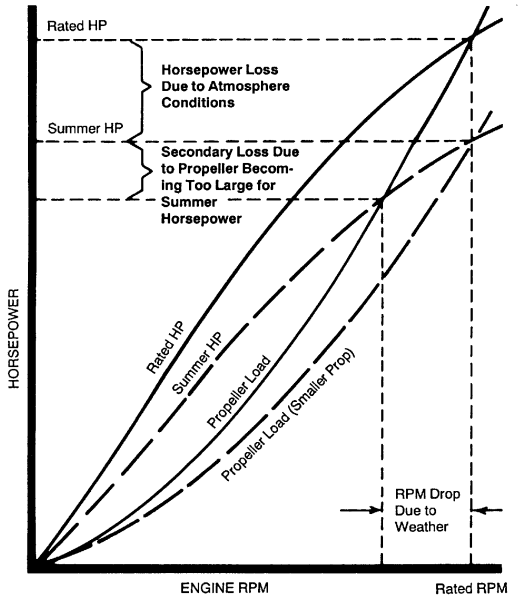
When a boat loses performance, check bilge for water. Water can add considerable weight to the boat, thereby decreasing the performance and handling.

Make certain that all drain passages are open for complete draining.

Elevation and Climate

Elevation has a very noticeable effect on the wide-open- throttle power of an engine. Since air (containing oxygen) gets thinner as elevation increases, the engine begins to starve for air. Humidity, barometric pressure and temperature do have a noticeable effect on the density of air. Heat and humidity thin the air. This phenomenon can become particularly annoying when an engine is propped out on a cool dry day in spring and later, on a hot, sultry day in August, doesn't have its old zip. (See chart.)

Although some performance can be regained by dropping to a lower pitch propeller, the basic problem still exists. The propeller is too large in diameter for the reduced power output. The experienced marine dealer or a Quicksilver Propeller Repair Station can determine how much diameter to remove from a lower-pitch propeller for specific high-elevation locations. In some cases, a gear-ratio change to the drive unit to more reduction is possible and very beneficial. It is a known fact that weather conditions exert a profound effect on power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated RPM under a specific combination of weather conditions.



72006

IMPORTANT INFORMATION

1

B

Tune-Up Specifications

Model	MCM 4.3L	MCM 4.3LX
Propshaft Horsepower Ratings (Kilowatts)	155 (115)	175 (130)
Number of Cylinders	6	
Displacement	262 Cu. In. (4.3 L)	
Bore/Stroke	4.00/3.48 In. (101.6/88.4 mm)	
Compression Ratio	9.3:1	
Compression Pressure	180 PSI (1241 kPa)	
Idle RPM (in Forward Gear)	650-700	
Max. RPM (at W.O.T.)	4400-4800	
(at 2000 RPM)	30-55 PSI (207-379 kPa)	
	4 PSI (28 kPa)	
	3-7 PSI (21-48 kPa)	
	V Negative (–) Ground	

MAINTENANCE

Index

Table of Contents

	Page
Maintenance Schedules	1B-1
Maintenance Intervals	1B-1
Alpha Models	1B-1
Bravo Models	1B-4
Tune-Up Specifications	1B-7
Fluid Capacities	1B-9
20-Hour Break-In Period	1B-10
Fuel, Oil, Fluid, and Coolant Specifications	1B-10
Fuel	1B-10
Crankcase Oil	1B-12
Power Steering Fluid	1B-13
Coolant for Closed Cooling System	1B-13
Maintaining Crankcase Oil Level	1B-13
Overfilled Engine Crankcase	1B-13
Checking Engine Oil Level/Filling	1B-13
Changing Oil and Filter	1B-14
Maintaining Power Steering Pump Fluid Level	1B-14
With Engine Warm	1B-14
With Engine Cold	1B-15
Filling and Bleeding Power Steering System	1B-15
Maintaining Closed Cooling Coolant Level	1B-16
Flushing Cooling System	1B-16
Lubrication	1B-18
Throttle Cable	1B-18
Shift Cable	1B-19
Engine Coupler/U-Joint Shaft Splines	1B-19
Audio Warning System	1B-20
Maintenance	1B-20
Cold Weather or Extended Storage	1B-20
Precautions	1B-20
Layup	1B-21
Draining Instructions	1B-22
Draining Seawater (Raw-Water) Cooled Models	1B-22
Draining Seawater Section of Closed Cooled (Coolant) Models	1B-25
Recommissioning	1B-27

Maintenance Schedules

Maintenance Intervals

Maintenance intervals and the tasks to be performed, as shown in this current schedule, or as found in a previously printed schedules, are generally based on an average boating application and environment. However, individual operating habits and personal maintenance preferences can have an impact on the suggested intervals. In consideration of these factors, MerCruiser has adjusted some maintenance intervals and corresponding tasks to be performed. In some cases, this may allow for more individual tasks to be performed in a single visit to the serving dealer, rather than multiple visits. Therefore, it is very important that the boat owner and servicing dealer discuss the current Maintenance Schedule and develop appropriate maintenance intervals to coincide with the individual operating habits, environment, and maintenance requirements.

Alpha Models

SCHEDULED MAINTENANCE THAT CAN BE PERFORMED BY OWNER/OPERATOR

NOTE: *Only perform maintenance which applies to your particular power package.*

Task	Interval
Engine Crankcase Oil - Check level	Weekly
Closed Cooling Coolant - Check level	
Power Steering Fluid - Check level	
Stern Drive Unit Oil - Check level	
Battery - Check level and inspect for damage	
Fuel Pump Sight Tube (If so Equipped) - Check that no fuel is present	
Power Trim Pump Oil - Check level	
Anodes - Inspect for erosion	
Gear Housing Water Pickups - Check for marine growth or debris	
Drive Belt(s) - Inspect condition and check tension	Every 100 hours of operation or 120 days. Whichever occurs first.
Propeller Shaft - Lubricate	**Saltwater Use**: Every 50 hours of operation or 60 days, Whichever occurs first. **Freshwater Use:** Every 100 hours of operation or 120 days, Whichever occurs first.
Power Package - Exterior Surfaces - Spray with rust preventative	
Power Package Exterior Surfaces - Clean and paint	Once a year
Cooling System - Flush seawater section	**Saltwater Use:** After every use.

SCHEDULED MAINTENANCE THAT CAN BE PERFORMED BY DEALER

NOTE: *Only perform maintenance which applies to your particular power package.*

Task	Interval
Seawater Pickup Pump - Disassemble and inspect	Whenever insufficient seawater flow is suspected. (If operating temperature exceeds normal range.)
Crankcase Oil and Filter Change	End of first boating season and thereafter, every 100 hours of operation or once yearly, whichever occurs first.
Ignition system - Clean and Inspect condition.	
Flame Arrestor and Crankcase Ventilation Hose - Clean and Inspect.	
Positive Crankcase Ventilation (PCV) Valve (If Equipped) - Change	
Stern Drive unit Oil - Change	
Gimbal Ring Clamping Screws Retorque to 50-55 ft. lb. (67-74 N·m)	
Rear Engine Mounts Check torque to 30-40 ft. lb. (47-54 N·m)	
Gimbal Bearing - Lubricate	
Cooling System - Clean and Inspect	
Steering System - Lubricate and inspect for loose, damage or missing parts.	
Electrical System - Check for loose or damaged wiring.	
Closed Cooling System Pressure Cap - Clean, inspect and test .	
Cooling System Hoses and Clamps - Inspect for damage and deterioration. Check clamps for tightness.	
Continuity Circuit - Check components for loose connections, broken or frayed wires.	
Shift and Throttle Cable and Linkage - Lubricate and inspect for loose, damaged or missing parts.	
Engine Exhaust System - Inspect externally for damage, deterioration and restrictions. Check for tightness.	
Ignition System - Check Timing and adjust as needed.	

SCHEDULED MAINTENANCE THAT CAN BE PERFORMED BY DEALER (CONTINUED)

NOTE: *Only perform maintenance which applies to your particular power package.*

Task	Interval
Steering Head and Remote Control - Inspect and lubricate.	End of first boating season and thereafter, every 100 hours of operation or once yearly, whichever occurs first.
Carburetor (If Equipped) - Inspect and adjust.	
Throttle Body (EFI Models) - Inspect.	
Fuel Filters - Replace.	Once a Year
Quicksilver Mercathode System - Test output.	
Closed Cooling Coolant - Test for Alkalinity	
Heat Exchanger - Clean seawater section.	
Drive Unit Bellows and Clamps - Inspect.	
Engine Alignment - Check.	End of first boating season and thereafter, **Saltwater Use:** Every 300 hours of operation or once yearly, whichever occurs first **Freshwater Use:** Every 300 hours of operation or once every two years, whichever occurs first.
Engine Coupling Universal Joint Shaft Splines - Lubricate.	
Universal Joint Cross Bearings- Inspect.	
Closed Cooling Coolant - Replace.	Every Two Years

Bravo Models

SCHEDULED MAINTENANCE THAT CAN BE PERFORMED BY OWNER/OPERATOR

NOTE: *Only perform maintenance which applies to your particular power package.*

Task	Interval
Engine Crankcase Oil - Check level	Weekly
Closed Cooling Coolant - Check level	
Power Steering Fluid - Check level	
Stern Drive Unit Oil - Check level	
Battery - Check level and inspect for damage	
Fuel Pump Sight Tube (If so Equipped) - Check that no fuel is present	
Power Trim Pump Oil - Check level	
Anodes - Inspect for erosion	
Gear Housing Water Pickups - Check for marine growth or debris	
Drive Belt(s) - Inspect condition and check tension	Every 100 hours of operation or 120 days. Whichever occurs first.
Propeller Shaft - Lubricate	**Saltwater Use**: Every 50 hours of operation or 60 days, Whichever occurs first. **Freshwater Use:** Every 100 hours of operation or 120 days, Whichever occurs first.
Power Package - Exterior Surfaces - Spray with rust preventative	
Power Package Exterior Surfaces - Clean and paint	Once a year
Cooling System - Flush seawater section	**Saltwater Use:** After every use.

SCHEDULED MAINTENANCE THAT SHOULD BE PERFORMEDBY A DEALER (CONTINUED)

NOTE: *Only perform maintenance which applies to your particular power package.*

Task	Interval
Seawater Pickup Pump - Disassemble and inspect	Whenever insufficient seawater flow is suspected. (If operating temperature exceeds normal range.)
Crankcase Oil and Filter Change	End of first boating season and thereafter, every 100 hours of operation or once yearly, whichever occurs first.
Ignition system - Clean and Inspect condition.	
Flame Arrestor and Crankcase Ventilation Hose - Clean and Inspect.	
Positive Crankcase Ventilation (PCV) Valve (If So Equipped) - Change	
Stern Drive unit Oil - Change	
Gimbal Ring Clamping Screws - Retorque to 40 ft. lb. (54 N·m)	
Rear Engine Mounts - Check torque to 30-40 ft. lb. (47-54 N·m)	
Gimbal Bearing - Lubricate	
Cooling System - Clean and Inspect	
Engine Alignment - Check	
Engine Coupling Universal Joint Shaft Splines - Lubricate	
Steering System - Lubricate and inspect for loose, damage or missing parts.	
Electrical System - Check for loose or damaged wiring.	
Cooling System Hoses and Clamps - Inspect for damage and deterioration. Check Clamps for tightness.	
Closed Cooling System Pressure Cap - Clean, inspect and test .	
Continuity Circuit - Check components for loose connections, broken or frayed wires.	
Shift and Throttle Cable and Linkage - Lubricate and inspect for loose, damaged or missing parts	
Engine Exhaust System - Inspect externally for damage, deterioration and restrictions. Check for tightness.	
Ignition System - Check Timing and adjust as needed.	

SCHEDULED MAINTENANCE THAT SHOULD BE PERFORMEDBY A DEALER (CONTINUED)

NOTE: *Only perform maintenance which applies to your particular power package.*

Task	Interval
Steering Head and Remote Control - Inspect and Lubricate.	End of first boating season and thereafter, every 100 hours of operation or once yearly, whichever occurs first.
Carburetor (If Equipped) - Inspect and adjust.	
Throttle Body (EFI Models) - Inspect	
Fuel Filters - Replace	Once a Year
Quicksilver Mercathode System - Test output.	
Closed Cooling Coolant - Test for Alkalinity	
Heat Exchanger - Clean seawater section.	
Drive Unit Bellows and Clamps - Inspect	
Universal Joint Cross Bearings- Inspect	End of first boating season and thereafter, every 200 hours of operation or once yearly, whichever occurs first.
Closed Cooling Coolant - Replace	Every Two Years

Tune-Up Specifications

MODEL	MCM 4.3L	MCM 4.3 LX
Propshaft Horsepower Ratings (Kilowatts) [1]	155 (115)	175 (130)
Number Of Cylinders	6	
Displacement	262 Cu. In. (4.3L)	
Bore/Stroke	4.00/3.48 (101.6/88.4 mm)	
Compression Ratio	9.3:1	
Compression Pressure	180 PSI (1241 kPa)	
Idle RPM In Neutral [2]	650-700	
Max RPM (at W.O.T.)	4400-4800	
Oil Pressure (at 2000 RPM)	30-55 PSI (207-379 kPa)	
Min. Oil Pressure	4 PSI (28 kPa)	
Fuel Pump Pressure	3-7 PSI (21-48 kPa)	
Electrical System	12 Volt Negative (–) Ground	
Min. Battery Cold Cranking Amperes	375 cca/475 mca/90 Ah	
Firing Order	1-6-5-4-3-2	
Spark Plug Type	AC-MR43T / Champion RV15YC4 / NGK BR6FS	
Spark Plug Gap	.040 In. (1 mm)	
Timing Thunderbolt IV Models [3]	8° BTDC	
Thunderbolt V Models [3]	10° BTDC	
Preliminary Idle Mixture	1-1/4 Turn	
Thermostat	143° F (62° C)	

[1] Power Rated in Accordance with NMMA (National Marine Manufacturers' Association) rating procedures.

[2] Measured using an accurate service tachometer and fuel injection engine at operating temperature.

[3] Timing must be set using a special procedure as outlined in the appropriate Service Manual. Timing cannot be properly set using the conventional method.

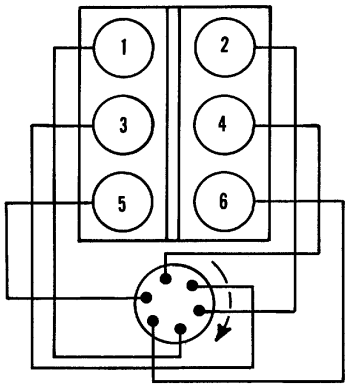
Tune-Up Specifications

MODEL	MCM 4.3LX GEN + ALPHA AND BRAVO (2 BBL)	MCM 4.3LXH GEN + ALPHA AND BRAVO (4 BBL)	MCM 262 MAGNUM EFI GEN + ALPHA AND BRAVO
Propshaft Ratings HP.(KW)[1]	190 (142)	205 (153)	205 (153)
Displacement	262 CID (4.3L)		
Bore/Stroke In. (mm)	4.00 x 3.48 (101.6 x 88.4)		
Compression Ratio	9.4:1		
Compression Pressure	180 PSI (1241 kPa)		
Idle RPM In Neutral [2]	650		600
Maximum RPM (at W.O.T.)	4400-4800		
Oil Pressure (at 2000 RPM)	30-55 PSI (207-379 kPa)		
Minimum Oil Pressure (at Idle)	4 PSI (28 kPa)		
Fuel Pump Pressure	3-7 PSI (21-48 kPa)		
Fuel Pressure (Running) (E.F.I. Only)	Does Not Apply		30 PSI (207 kPa)
Electrical System	12 V Negative (–) Ground		
Minimum Battery Requirements	550 cca / 700 mca / 120 Ah		
Firing Order	1-6-5-4-3-2		
Spark Plug Type	AC - MR43LTS Champion RS12YC NGK BPR6EFS		
Spark Plug Gap	.045 (1.1 mm)		
Timing (at Idle RPM)[3]	10° BTDC		8° BTDC
Preliminary Idle Mixture	1-1/4 Turns		Does Not Apply
Thermostat	160° F (71° C)		

[1] Power Rated in Accordance with NMMA (National Marine Manufacturers' Association) rating procedures.

[2] Measured using an accurate service tachometer and fuel injection engine at operating temperature.

[3] Timing must be set using a special procedure as outlined in the appropriate Service Manual. Timing cannot be properly set using the conventional method.



Firing Order
1-6-5-4-3-2

72976

Fluid Capacities

NOTICE

All capacities are approximate fluid measures.

MCM (Stern Drive) Model	All Models
Crankcase Oil[1] (with filter)	4-1/2 U.S. Qts. (4.3 L)
Seawater Cooling System[2]	15 U.S. Qts. (14.1 L)
Closed Cooling System	20 U.S. Qts. (19 L)

[1]Always Use Dipstick to Determine Exact Quantity of Oil Required
[2]Seawater Cooling System Capacity Information is for Winterization Use Only

20-Hour Break-In Period

IMPORTANT: The first 20 hours of operation is the engine break-in period. Correct break-in is essential to obtain minimum oil consumption and maximum engine performance. During this break-in period, the following rules must be observed:

- Do not operate below 1500 RPM for extended periods of time for first 10 hours. Shift into gear as soon as possible after starting and advance throttle above 1500 RPM if conditions permit safe operation.
- Do not operate at one speed consistently for extended periods.
- Do not exceed 3/4 throttle during first 10 hours. During next 10 hours, occasional operation at full throttle is permissible (5 minutes at a time maximum).
- Avoid full throttle acceleration from idle speed.
- Do not operate at full throttle until engine reaches normal operating temperature.
- Frequently check crankcase oil level. Add oil if needed. It is normal for oil consumption to be high during break-in period.
- After 20-hour break-in period, drain crankcase oil and replace oil filter (see “Maintenance”). Fill crankcase with correct oil (see “Specifications”).

Fuel, Oil, Fluid, and Coolant Specifications

Fuel

⚠CAUTION

Use of improper gasoline can damage the engine seriously. Engine damage that results from use of improper gasoline is considered misuse of the engine and is not covered under MerCruiser Warranty.

USA and Canada
Fuel having a posted pump Octane Rating of 87(R + M)/2 minimum. Premium gasoline [92 (R + M)/2] is also acceptable. DO NOT use leaded gasoline.
Outside USA and Canada
Fuel having a posted pump Octane Rating of 92 RON minimum. Premium gasoline (98 RON) is also acceptance. If unleaded is not available, use a major brand of leaded gasoline.

Gasolines containing alcohol, either methyl alcohol (methanol) or ethyl alcohol (ethanol) may cause increased:

- Corrosion of metal parts.
- Deterioration of elastomer and plastic parts.
- Fuel permeation through flexible fuel lines.
- Wear and damage of internal engine parts.
- Starting and operating difficulties.

Some of these adverse effects are due to the tendency of gasolines containing alcohol to absorb moisture from the air, resulting in a phase of water and alcohol separating from the gasoline in the fuel tank.

The adverse effects of alcohol are more severe with methyl alcohol (methanol) and are worse with increasing alcohol content.

⚠ WARNING

Fire and Explosion Hazard: Fuel leakage from any part of the fuel system can be a fire and explosion hazard which can cause serious bodily injury or death. Careful periodic inspection of the entire fuel system is mandatory, particularly after storage. All fuel system components including fuel tanks (whether plastic, metal or fiberglass), fuel lines, primer bulbs, fittings, fuel filters and carburetors should be inspected for leakage, softening, hardening, swelling or corrosion. Any sign of leakage or deterioration requires replacement before further engine operation.

Because of possible adverse effects of alcohol in gasoline, it is recommended that only alcohol-free gasoline be used where possible. If only fuel containing alcohol is available, or if the presence of alcohol is unknown, increased inspection frequency for leaks and abnormalities is required.

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

IMPORTANT: When operating a MerCruiser engine on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods should be avoided. Long periods of storage, common to boats, create unique problems. In cars, alcohol-blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

NO LEAD GASOLINE

U.S. Environmental Protection Agency (EPA) and Canadian government regulations require the removal of lead (anti-knock compound) from all gasoline because lead emission in exhaust is a health hazard.

In order to maintain octane ratings, many gasoline manufacturers are adding ethyl alcohol (ethanol) or methyl alcohol (methanol) to the gasoline to replace the lead.

The use of any good grade unleaded regular or premium gasolines with a minimum posted octane rating [(A.K.I.) Anti-Knock Index] of 87, are satisfactory for use in your engine. In areas where unleaded regular or premium gasolines are not available, a good grade **leaded** regular with a minimum posted octane rating (A.K.I.) of 89 may be used.

GASOLINE/ALCOHOL BLENDS

Many new motor vehicle owner manuals are warning about the potential damage from using gasoline containing alcohol, especially METHANOL. They cite possible fuel system damage and performance problems. These are just two of the hazards that may be caused by alcohol. These same problems as well as the additional safety risk of fire and explosion from fuel system leaks apply to marine inboard engines. METHANOL is more severe in its bad effect than is ETHANOL. Alcohol is also more severe in older engines since newer engines have materials which are more resistant to alcohol.

EFFECTS OF GASOLINE/ALCOHOL BLENDS ON MARINE ENGINES

Corrosion of metals may result from use of alcohol-gasoline blends. Portable or permanently installed fuel tanks of metal or fiberglass, fuel filters, fuel lines and float bowls may be affected by alcohol blended fuels. Many fiberglass fuel tanks are slowly dissolved by alcohol, leading immediately to filter and carburetor plugging and eventually to tank failure.

Fuels containing alcohol will absorb moisture from the air. At first, this moisture will remain in solution, but once the water content of the fuel has built up to about one-half of one percent, it will separate out (phase separation), bringing the alcohol with it. This alcohol-water mixture settles to the bottom of the fuel tank and if this mixture gets into the engine, the engine can be seriously damaged internally, as it may wash the protective film of oil off the bore of any cylinder that it enters. Before the engine can be restarted, it is necessary to remove the separated alcohol and water layer, flush out the fuel system with clean fuel and remove and dry the spark plugs.

BOAT/MOTOR STORAGE

When operating a MerCruiser engine on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods of time should be avoided.

Long periods of storage, common to boats, create unique problems. In cars, gasoline/alcohol blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

WINTER STORAGE

If boat is to be placed in winter storage, carburetors must be run dry at idle RPM. Permanent fuel tanks should be drained completely and Quicksilver Gasoline Stabilizer and Conditioner added to any fuel remaining in the tank. Portable fuel tanks should be emptied completely.

WARRANTY

Performance problems and fuel system or other damage resulting from the use of gasoline-alcohol blended fuels are not the responsibility of MerCruiser and will not be covered under our warranty.

CONTINUING EVALUATIONS

The effects of gasoline with ETHANOL and METHANOL are still being evaluated by the United States Coast Guard, the National Marine Manufacturers Association (NMMA), Mercury Marine and other engine and boat manufacturers.

We have recommended pump posting of alcohol content of gasoline. Further we recommend using gasoline known not to contain any METHANOL or ETHANOL when possible.

TEST FOR ALCOHOL CONTENT IN GASOLINE

The following is an acceptable and widely used field procedure for the detection of alcohol in gasoline. Use any small transparent bottle or tube that can be capped and is, or can be, provided with graduations or a mark at about 1/3 full. A pencil mark on a piece of adhesive tape may be used.

Procedure

1. Fill the container with water to the mark.
2. Add fuel almost to fill the container, leaving some air space, then cap the container. The proportions of fuel to water are not critical, but there should be 2 to 3 times as much fuel as water.
3. Shake container vigorously and allow it to sit **upright for 3 to 5 minutes**. If the volume of water appears to have increased, alcohol is present. If you are not sure, there is no need for concern. If the dividing line between water and fuel becomes cloudy, use the middle of the cloudy band.

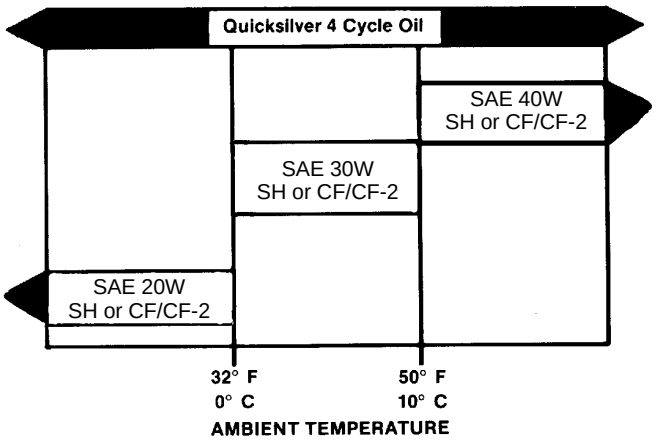
Crankcase Oil

To help obtain optimum engine performance and to provide maximum protection, we strongly recommend the use of Quicksilver 4-Cycle Marine Engine Oil. If not available, a good grade, straight weight, detergent automotive oil of correct viscosity, with an API classification of SF or SG, may be used.

The following chart is a guide to crankcase oil selection. Oil filter should always be changed with oil.

In those areas where recommended straight weight oil is not available, a multi-viscosity 20W-40 (SF or SG) or, as a second but less preferable choice, 20W-50 (SF or SG) may be used.

IMPORTANT: The use of non-detergent oils, multi-viscosity oils (other than 20W-40 or 20W-50), low quality oils or oils which contain solid additives specifically are not recommended.



72010

Power Steering Fluid

Use Quicksilver Power Trim and Steering Fluid, or automatic transmission Fluid (ATF), Dexron, Dexron II or Dexron III.

Coolant for Closed Cooling System

⚠CAUTION

Alcohol or Methanol base antifreeze or plain water, are not recommended for use in fresh water section of cooling system at any time.

We recommend that the coolant section of closed cooling system be filled with Quicksilver Pre-Mixed Engine Coolant. In areas where the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

MerCruiser V-6 engines can use any type of permanent antifreeze or any brand antifreeze solution that meets GM specification 1825M.

Maintaining Crankcase Oil Level

Overfilled Engine Crankcase

Overfilled crankcases (oil level being too high) can cause a fluctuation or drop in oil pressure and rocker arm "clatter" on MerCruiser engines. The over-full condition results in the engine crankshaft splashing and agitating the oil, causing it to foam (become aerated). The aerated oil causes the hydraulic valve lifters to "bleed down." This, in turn, results in rocker arm "clatter" and loss of engine performance, due to the valves not opening properly.

Care must be taken when checking engine oil level. Oil level must be maintained between the ADD mark and the FULL mark on the dipstick. To ensure that you are not getting a "false reading," make sure the following steps are done before checking the oil level.

- Boat "at rest" in the water, or
- If boat is on a trailer, raise or lower bow until the boat is setting at the approximate angle that it would be if setting "at rest" in the water.
- Allow sufficient time for oil to drain into the crankcase if engine has just been run or oil has just been added.

Checking Engine Oil Level/Filling

IMPORTANT: ENGINE CRANKCASE OIL MUST BE CHECKED AT INTERVALS SPECIFIED IN "MAINTENANCE SCHEDULE" CHART. It is normal for an engine to use a certain amount of oil in the process of lubrication and cooling of the engine. The amount of oil consumption is greatly dependent upon engine speed, with consumption being highest at wide-open-throttle and decreasing substantially as engine speed is reduced.

1. Stop engine and allow boat to come to a rest.
2. Allow oil to drain back into oil pan - approximately 5 minutes.
3. Remove dipstick. Wipe clean and reinstall. Push dipstick all the way into dipstick tube.
4. Remove dipstick and note the oil level.
5. Oil level must be between the FULL and ADD marks.
6. If oil level is below ADD mark, proceed to Steps 7 and 8.
7. Remove oil filler cap from valve rocker arm cover.
8. Add required amount of oil to bring level up to, but not over, the FULL mark on dipstick.

Changing Oil and Filter

1. Start engine and run until it reaches normal operating temperatures.

IMPORTANT: Change oil when engine is warm from operation, as it flows more freely, carrying away more impurities.

2. Stop engine.
3. Remove drain plug from oil pan or from oil drain hose.

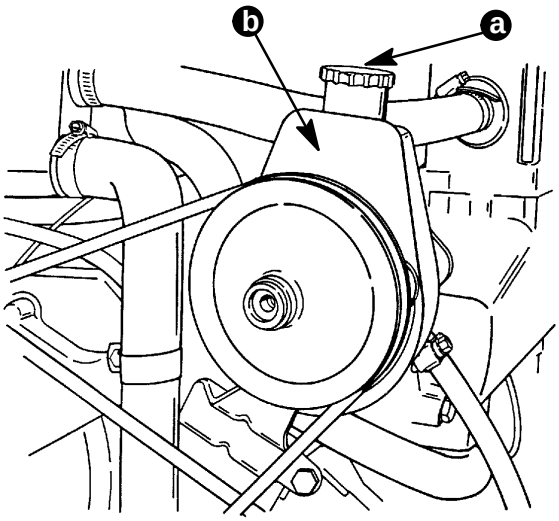
NOTE: *If drain plug is not accessible because of boat construction, oil may be removed through dipstick tube, using a Quicksilver Crankcase Oil Pump.*

4. After oil has drained completely, reinstall drain plug (if removed) and tighten securely.
5. Remove and discard oil filter and its sealing ring.
6. Coat sealing ring on new filter with engine oil, and install. Tighten filter securely (following filter manufacturer's instructions). Do not over-tighten.
7. Fill crankcase with oil.
8. Start engine and check for leaks.

Maintaining Power Steering Pump Fluid Level

With Engine Warm

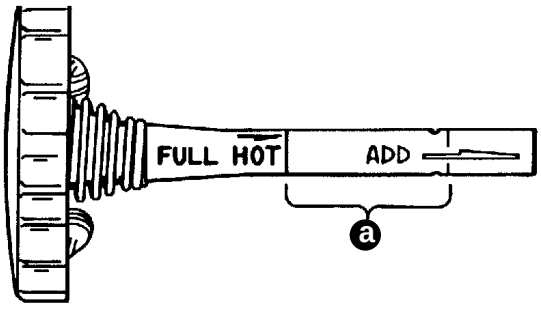
1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from power steering pump and note fluid level.



72517

a - Fill Cap / Dipstick
b - Power Steering Pump

3. Level should be between the FULL HOT mark and ADD mark on dipstick.



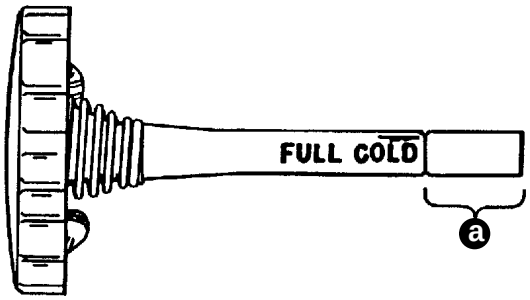
72518

a - Proper Fluid Level With Engine Warm

4. If level is below ADD mark, but fluid is still visible in pump reservoir, add required amount of Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF), Dexron, or Dexron II, through fill cap opening, to bring level up to FULL HOT mark on dipstick. DO NOT OVERFILL.
5. If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

With Engine Cold

1. With engine stopped, position drive unit so that it is straight back.
2. Remove fill cap/dipstick from power steering pump and note fluid level.
3. Level should be between FULL COLD mark and bottom of dipstick.



72519

a - Proper Fluid Level With Engine Cold

4. If level is below bottom of dipstick, but fluid is still visible in pump reservoir, add required amount of Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF), Dexron, Dexron II, or Dexron III through fill cap opening, to bring level up to FULL COLD mark on dipstick. DO NOT OVERFILL.

If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

Filling and Bleeding Power Steering System

IMPORTANT: Power steering system must be filled exactly as explained in the following to be sure that all air is bled from the system. All air must be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid also may cause power steering system to become spongy, which may result in poor boat control.

1. With engine stopped, position drive unit so that it is straight back. Remove fill cap/dipstick from power steering pump. Add Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF), Dexron, Dexron II, or Dexron III as required, to bring level up to FULL COLD mark on dipstick.

IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF), Dexron, Dexron II and Dexron III in power steering system.

2. Turn steering wheel back and forth to end of travel in each direction several times, then recheck fluid level and add fluid, if necessary.
3. Install vented fill cap.

⚠CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump, or pump impeller may be damaged and subsequent overheating damage to engine may result.

4. Start engine and run at fast idle (1000-1500 RPM) until engine reaches normal operating temperature. During this time, turn steering wheel back and forth to end of travel in each direction several times.
5. Position drive unit so that it is straight back and stop engine. Remove fill cap from pump. Allow any foam in pump reservoir to disperse, then check fluid level and add fluid, as required, to bring level up to FULL HOT mark on dipstick. DO NOT OVERFILL**.** Reinstall fill cap securely.

IMPORTANT: Drive unit must be positioned straight back and power steering fluid must be hot to accurately check fluid level.

6. If fluid is still foamy (in Step 5), repeat Steps 4 and 5 until fluid does not foam and level remains constant.

Index

Maintaining Closed Cooling Coolant Level

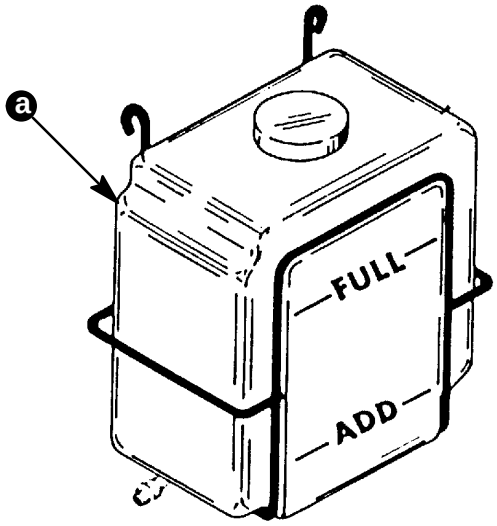
⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

1. Coolant level in heat exchanger should be full (to bottom of filler neck).

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts stop on filler neck.

2. Coolant level should be between the ADD and FULL marks on coolant recovery reservoir with the engine at normal operating temperature.



72520

a - Coolant Recovery Reservoir

Flushing Cooling System

If engine is operated in salty, polluted, or mineral-laden water, flush cooling system (preferably after each use) to reduce corrosion and prevent the accumulation of deposits in the system. Thoroughly flush cooling system prior to storage.

⚠WARNING

When flushing cooling system with boat out of the water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that propeller be removed.

⚠CAUTION

To prevent engine or stern drive unit damage DO NOT run engine or drive unit without water being supplied to water intake openings on gear housing, and to seawater pickup pump if so equipped.

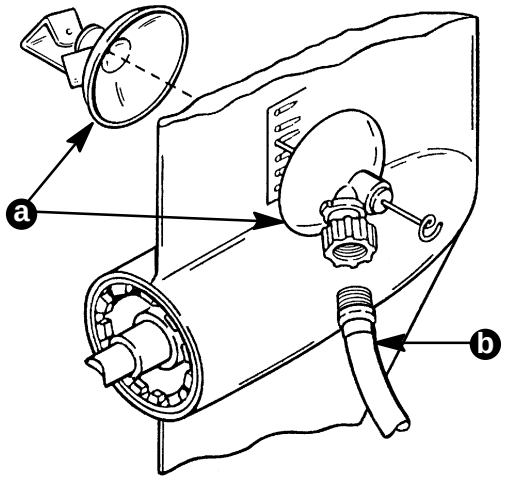
1. Follow instructions appropriate to your model:

NOTE: *If flushing cooling system with boat in water, raise drive unit to trailer position and install flushing attachment. Lower drive unit to full IN/DOWN position.*

a. **All Models:**

(1) Install Quicksilver Flushing Attachment (or equivalent) over water intake openings in gear housing.

(2) Connect hose between flushing attachment and water tap.



72012

a - Quicksilver Flushing Attachment
b - Garden Hose

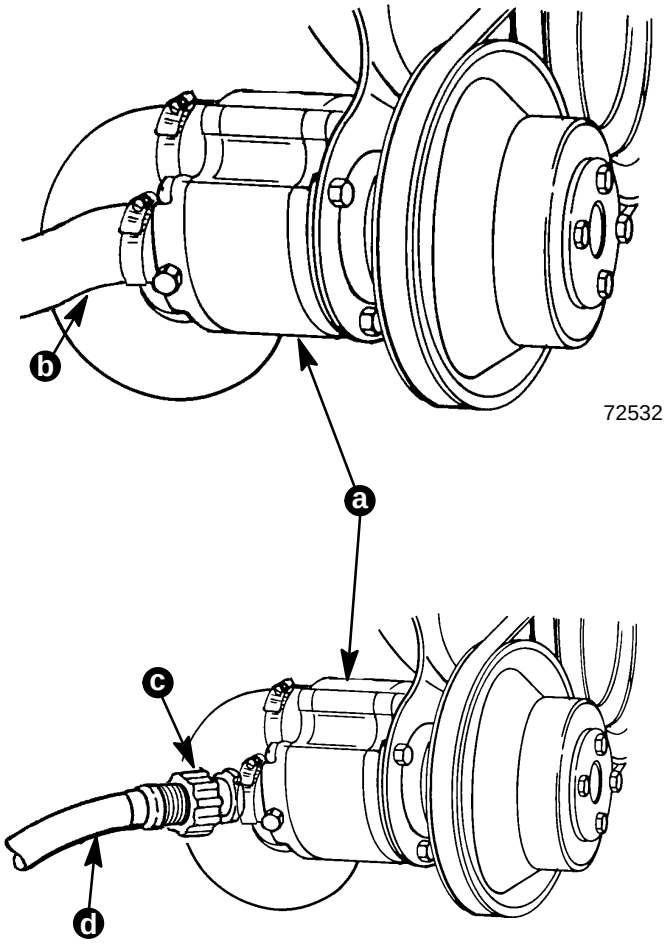
b. **Models Equipped with Belt Driven Seawater Pickup Pump:** In addition to supplying water to the drive (as previously outlined for "**All Models**"), perform the following.

⚠CAUTION

If cooling system is to be flushed with boat in the water, seacock (if so equipped) must be closed, or water inlet hose must be disconnected and plugged to prevent water from flowing into boat.

(1) Close seacock (if so equipped) or disconnect and plug seawater inlet hose.

(2) Loosen hose clamp and remove seawater inlet hose at location shown. Connect an additional tap water hose to inlet fitting using an appropriate adaptor.

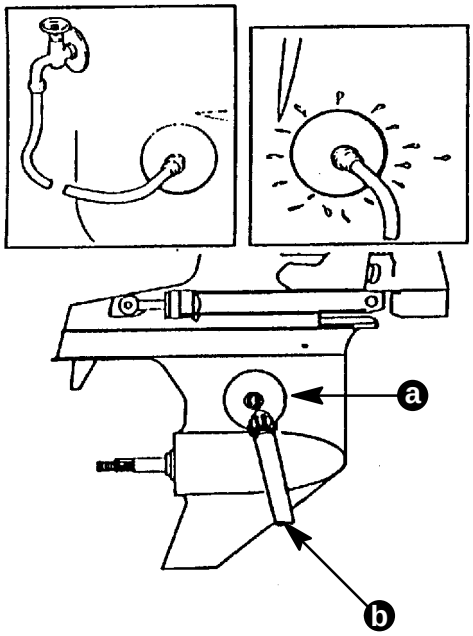


72532

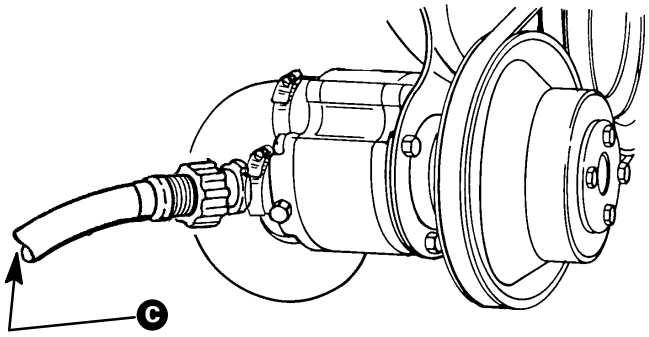
71843

a - Seawater Pickup Pump
b - Seawater Inlet Hose
c - Adaptor
d - Tap Water Hose

2. Partially open water tap(s) (approximately 1/2 maximum capacity) and allow drive unit and cooling system to fill completely. Do not use full tap water pressure.



72672



a - Quicksilver Flushing Attachment
b - Water To Drive Unit
c - Water To Seawater Pump (If So Equipped)

NOTE: *Drive unit is full when water is discharged out of drive unit, and/or seawater section of closed cooled system is full when water is discharged through propeller.*

⚠CAUTION

Do not run engine above 1500 RPM when flushing. Suction created by seawater pickup pump may collapse flushing hose, causing engine to overheat.

3. Place remote control lever in NEUTRAL position and start the engine.

⚠CAUTION

Watch temperature gauge at dash to ensure the engine does not overheat.

4. Operate engine at idle speed in NEUTRAL gear for 10 minutes or until discharge water is clear, then stop engine.
5. Shut off water tap(s).
6. Follow instructions appropriate to your model:

NOTE: *If flushing cooling system with boat in water, raise drive unit to trailer position, to remove flushing attachment. Lower drive unit to full IN/DOWN position after completion.*

a. **All Models:** Remove hose and flushing attachment from drive unit.

b. **Models Equipped with Belt Driven Seawater Pickup Pump:** Remove hose and flushing attachment from pump inlet.

7. Follow instructions “a” or “b.”

⚠CAUTION

If boat is in the water, seacock (if so equipped) must remain closed until engine is to be restarted, to prevent contaminated water from flowing back into cooling system. If boat is not fitted with a seacock, water inlet hose must remain disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engine.

a. **If equipped with seacock:** Observing precaution above, open seacock.

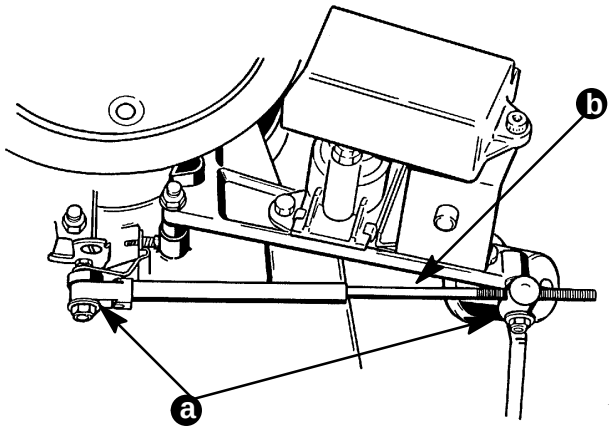
b. **If NOT equipped with seacock:** Observing precaution above, remove plug from seawater inlet hose and reconnect seawater inlet hose. Tighten hose clamps securely.

Lubrication

Lubricate pivot points with SAE 30W motor oil and cable guide contact surfaces with Quicksilver 2-4-C Marine Lubricant.

Throttle Cable

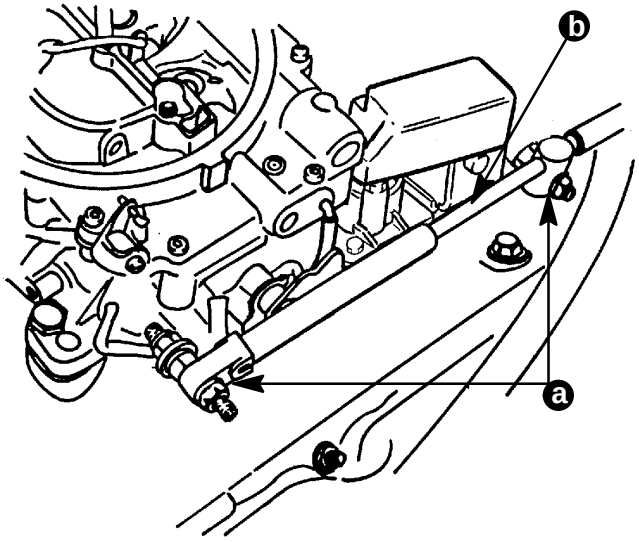
2 BARREL CARBURETOR



72013

a - Pivot Points
b - Guide Contact Surface

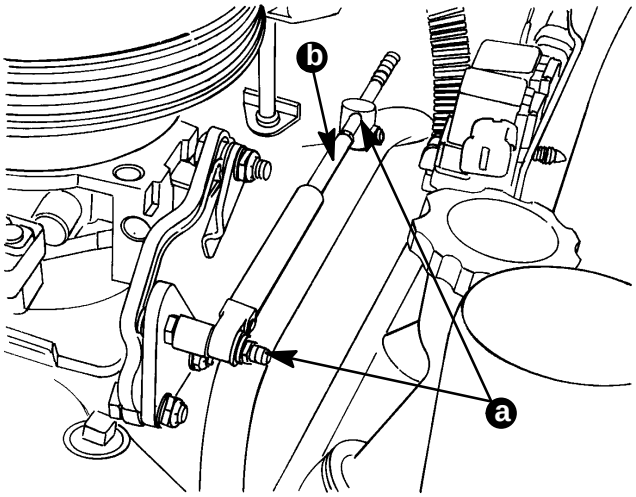
4 BARREL CARBURETOR



72014

a - Pivot Points
b - Guide Contact Surface

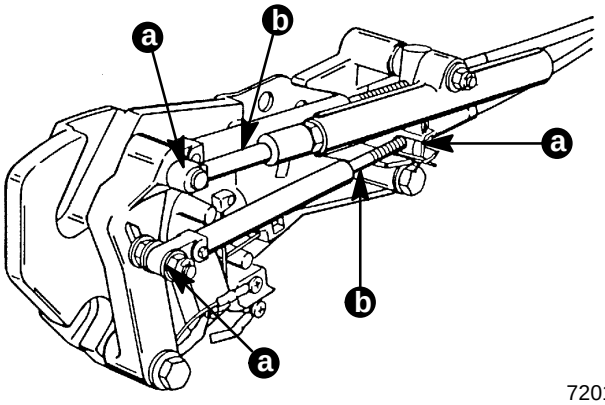
THROTTLE BODY FUEL INJECTION



74912

a - Pivot Points
b - Guide Contact Surface

Shift Cable



72015

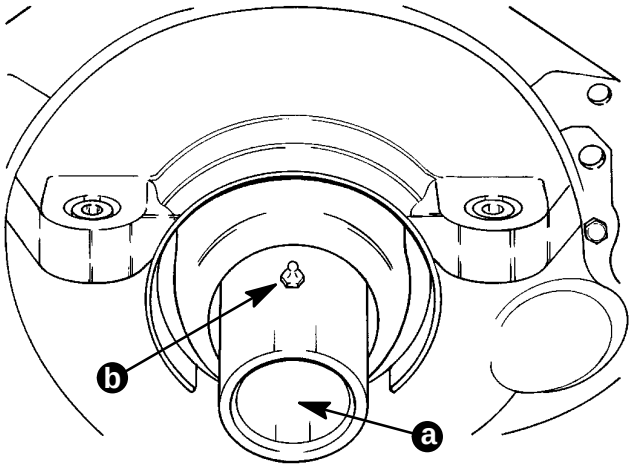
a - Pivot Points
b - Guide Contact Surface

Engine Coupler/U-Joint Shaft Splines

Lubricate coupler and splines with Quicksilver Engine Coupler Spline Grease (92- 816391A4).

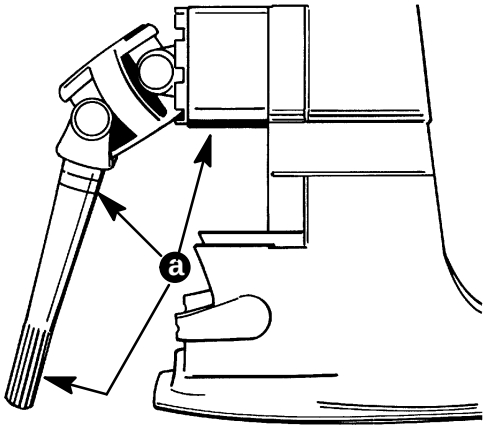
IMPORTANT: Stern Drive Unit does not have to be removed to grease coupler.

NOTE: *Refer to MerCruiser Stern Drive Service Manual for stern drive unit removal and installation if necessary.*



72017

a - Quicksilver Engine Coupler Spline Grease
b - Use Grease Fitting if Drive is Installed



72530

a - Quicksilver Engine Coupler Spline Grease (If Drive Has Been Removed)

Audio Warning System

Maintenance

Maintenance inspection is the owner's responsibility and must be performed at intervals specified, following:

Fresh Water Areas - Every 50 Hours of operation or 60 days (whichever comes first)

Salt Water Areas - Every 25 hours of operation or 30 days (whichever comes first)

NOTE: *Operation in salt water is considered severe service.*

1. Check buzzer mounting screws, heat switch and oil pressure switch for adequate tightness. Tighten, if loose, but DO NOT over-tighten.
2. Check all wiring connections to be sure that they are tight and sealed where necessary.

Cold Weather or Extended Storage

Precautions

⚠WARNING

BE CAREFUL while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF and do not smoke or allow sources of spark and/or open flames in the area.

⚠WARNING

To prevent a potential fire hazard, be sure that engine compartment is well ventilated and that there are no gasoline vapors present during starting or fogging of engine.

⚠CAUTION

DO NOT operate engine without water flowing through seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or stern drive unit may result.

⚠CAUTION

Seawater section of cooling system MUST BE COMPLETELY drained for winter storage, or immediately after cold weather use, if the possibility of freezing temperatures exists. Failure to comply may result in trapped water causing freeze and/or corrosion damage to engine.

⚠CAUTION

If boat is in the water, seacock (water inlet valve), if so equipped, must be closed until engine is to be re-started, to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be disconnected and plugged to prevent water from flowing back into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel of the boat with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting engine.

IMPORTANT: Observe the following information to ensure complete draining of cooling system.

- **Engine must be as level as possible.**
- **A wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages. Remove petcock, if necessary, to insert wire completely into drain hole.**

IMPORTANT: To prevent threads in manifolds, elbows and cylinder blocks from rusting out during storage, reinstall plugs using Quicksilver Perfect Seal on threads. Never leave drain plugs out during storage.

NOTE: *If possible, place a container under drains and hoses to prevent water from draining into boat.*

⚠ CAUTION

If engine is equipped with Closed Cooling System, Closed Cooling section must be kept filled with a solution of ethylene glycol antifreeze and water (mix antifreeze to manufacturer's recommended proportions to protect engine to lowest temperature to which it will be exposed). DO NOT USE PROPYLENE GLYCOL antifreeze in closed cooling section. Seawater section, however, must be drained completely.

⚠ CAUTION

A discharged battery can be damaged by freezing.

Layup

NOTICE

Refer to "Cold Weather or Extended Storage," "Precautions," in this section, BEFORE proceeding.

1. Fill fuel tank(s) with fresh gasoline that does not contain alcohol and a sufficient amount of Quicksilver Gasoline Stabilizer and Conditioner to treat the gasoline.

IMPORTANT: If boat is to be placed in storage (with fuel containing alcohol in fuel tanks), carburetors or vapor separator tanks must be run dry at idle RPM. Fuel tanks should be drained completely and Quicksilver Gasoline Stabilizer and Conditioner added to any fuel remaining in the tank. Also, refer to "Fuel Specifications," see Table of Contents.

2. Replace all fuel filters
3. Start engine and check for fuel leaks.
4. Run engine sufficiently to heat it to normal operating temperature; shut off engine and change oil and filter.
5. If boat has been operated in salty, polluted or mineral-laden waters, flush cooling system.
6. Prepare fuel system for extended storage as follows:

   a. **For engines with carburetors:**

   Remove flame arrestor assembly and restart engine. While operating engine at fast idle (1000-1500 RPM), fog internal surfaces of induction system and combustion chambers by squirting approximately 8 ounces (227 grams) of Quicksilver Storage Seal or SAE 20W engine oil into carburetor bores. Stall engine by squirting last 2 ounces (57 grams) of Storage Seal or oil rapidly into carburetor. Turn ignition to OFF.

   b. **For fuel injected engines with VST:**

⚠ WARNING

Fuel injection system is pressurized. A special procedure must be used to remove this pressure before removing the plug from vapor separator tank. DO NOT attempt to remove plug without having pressure removed. Fuel could spray on hot engine causing fire or explosion.

(1) Relieve fuel pressure from system. Refer to "Fuel Pressure Relief Procedure" in Section 5C.

(2) Remove plug from top of vapor separator tank.

(3) Add approximately 1 fluid ounce (30 ml) of Quicksilver 2-Cycle Outboard Oil to fuel in the vapor separator tank.

(4) Shut off the fuel supply to the engine's fuel pump.

(5) Start engine and run at idle speed until the vapor separator tank and fuel injection system is empty.

(6) Reinstall the plug in top of vapor separator tank.

c. **For fuel injected engines with Cool Fuel system:**

(1) Fill fuel tank(s) with fresh gasoline (that does not contain alcohol) and a sufficient amount of Quicksilver Gasoline Stabilizer for Marine Engines to treat gasoline. Follow instructions on container.

(2) **If boat is to be placed in storage with fuel containing alcohol in fuel tanks (if fuel without alcohol is not available):** Fuel tanks should be drained completely and Quicksilver Gasoline Stabilizer for Marine Engines added to any fuel remaining in the tank. Refer to "FUEL REQUIREMENTS" for additional information.

(3) Prepare fuel system for extended storage as follows:

(4) Allow engine to cool down.

(5) Remove the water separating fuel filter.

(6) Pour out a small amount of fuel into a suitable container, then add approximately 2 fluid ounces (60 ml) of Quicksilver 2-Cycle Outboard Oil to fuel in the water separating fuel filter.

(7) Install water separating fuel filter.

(8) Shut off the fuel supply to the engine.

(9) Start and run engine at idle speed for two minutes.

(10) Stop engine, remove and discard new water separating fuel filter and in line fuel filter.

(11) Install new filters.

(12) Close fuel shut-off valve, if so equipped.

7. Close fuel shutoff valve, if so equipped.
8. Clean flame arrestor and crankcase ventilation hoses and reinstall.
9. Lubricate all items outlined in "Lubrication."
10. Drain seawater section of cooling system, as outlined in "Draining Instructions" following.
11. **Closed Cooling System Models:** Test coolant to ensure that it will withstand lowest temperature expected during storage.
12. Service batteries.
13. Clean outside of engine and repaint any areas required with Quicksilver Primer and Spray Paint. After paint has dried, spray Quicksilver Corrosion and Rust Preventive Type II or wipe down with Quicksilver Storage Seal or SAE 20W engine oil.
14. For drive unit, refer to appropriate stern drive manual.

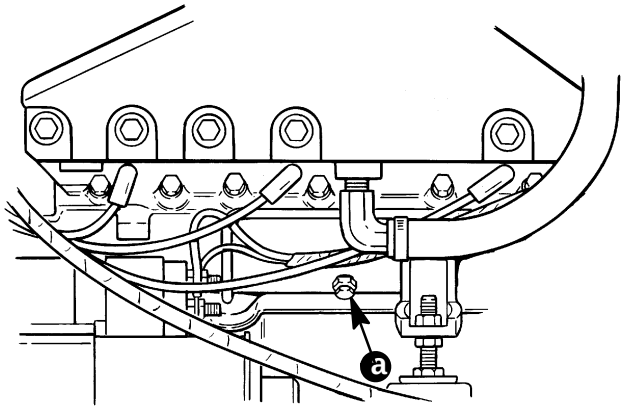
Draining Instructions

Draining Seawater (Raw-Water) Cooled Models

NOTICE

Refer to "Cold Weather or Extended Storage," "Precautions," in this section, BEFORE proceeding.

1. Engine must be as level as possible to ensure complete draining of cooling system.
2. Remove drain plugs (port and starboard) from cylinder block.



72993

Starboard Side Shown (Port Similar)

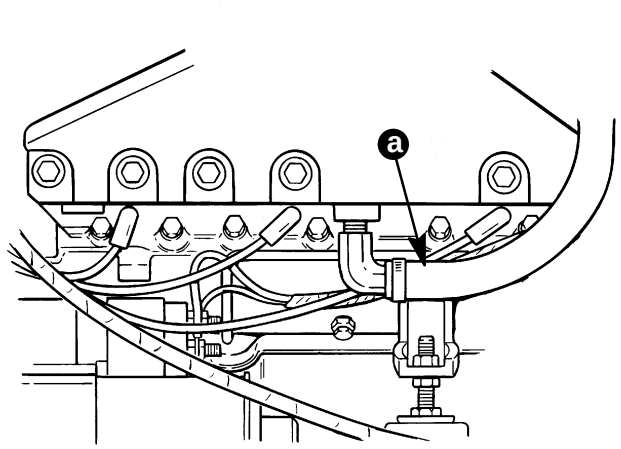
a - Drain Plug (Port and Starboard)

3. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses are disconnected.*

4. Remove hose from bottom of port and starboard manifolds. Some models may have drain plugs in elbows.

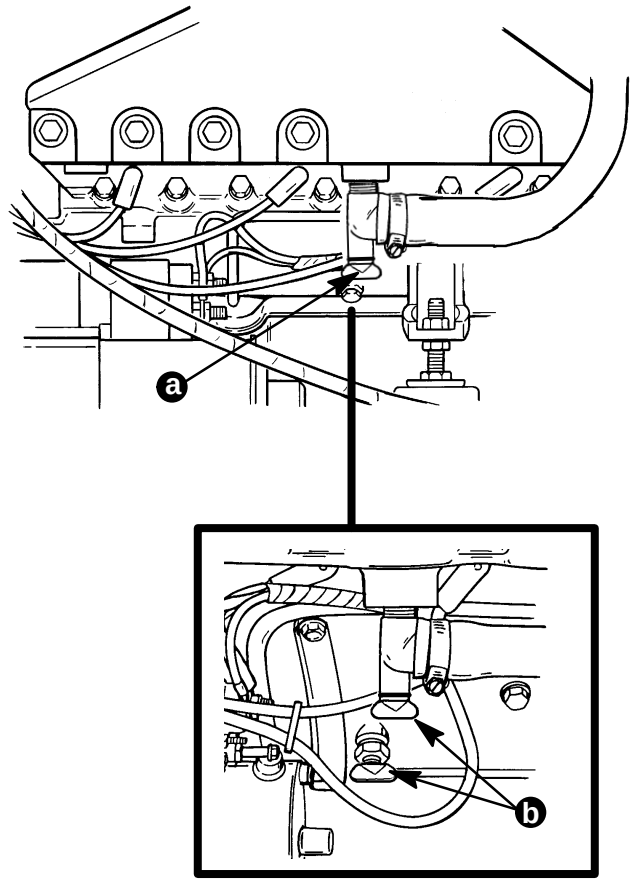
NOTE: *With the engine level, sufficient draining of manifolds will occur when exhaust manifold to thermostat housing hoses are removed.*



72993

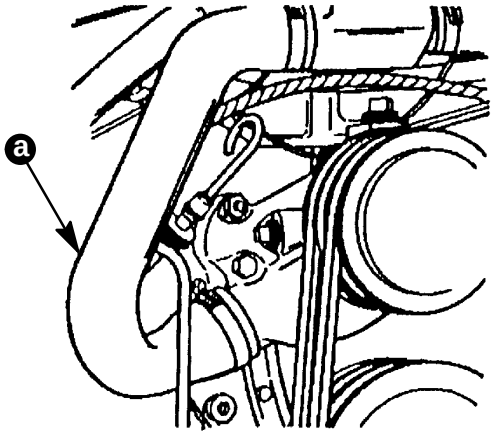
Starboard Side Shown (Port Similar)

a - Bottom Hose, Exhaust Manifold to Thermostat Housing



a - Drain Plug Located In Exhaust Manifold Elbow
b - Later Models Are Equipped With Thumbscrew Drain Plug.

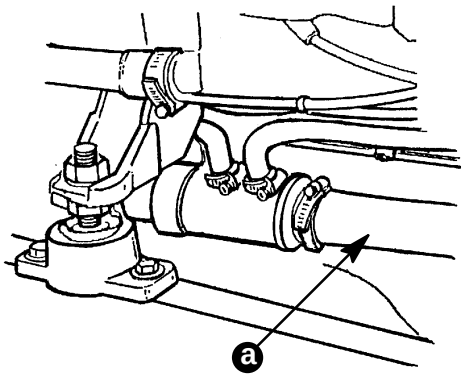
5. Remove the engine water circulating pump hose as shown.



72587

a - Hose, Water Circulating Pump to Thermostat Housing

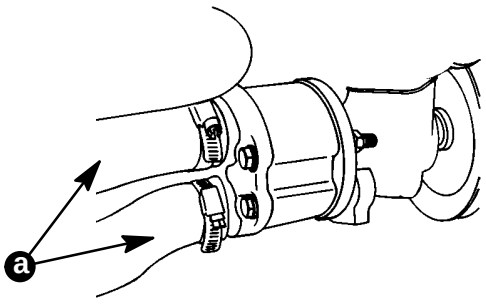
6. Remove the power steering fluid cooler seawater hose, as shown.



72588

a - Hose, Seawater Pump to Cooler

7. Bravo models need to remove both hoses form seawater pump.

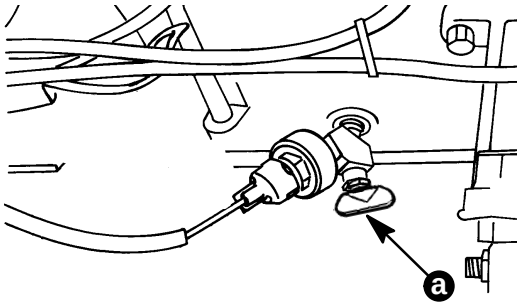


71170

a - Seawater Inlet And Outlet Hoses

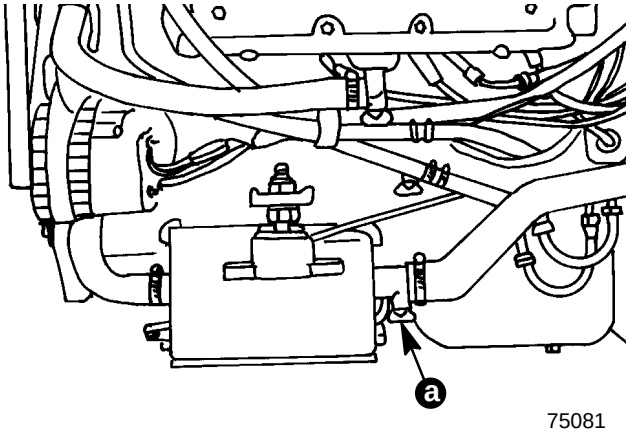
8. **For 1996 and newer models, the additional following steps must be performed:**

   a. Remove the drain plug from the Y-fitting form the port side of the block.

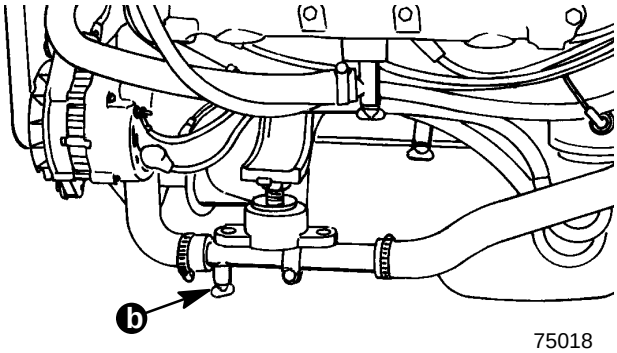


a - Drain Plug

   b. Remove the drain plug from the water tube (carburetor models) or Cool Fuel system (fuel injection models).



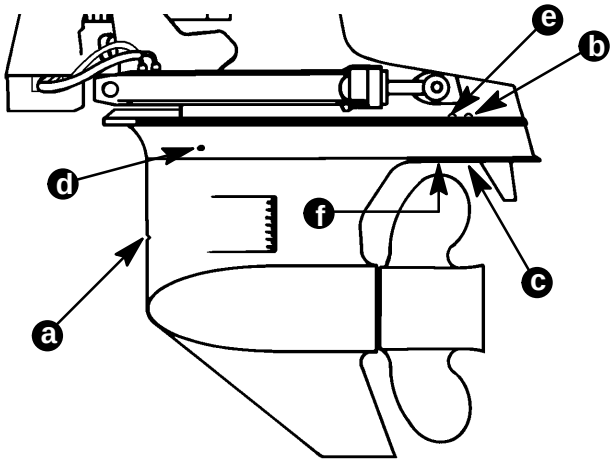
75081



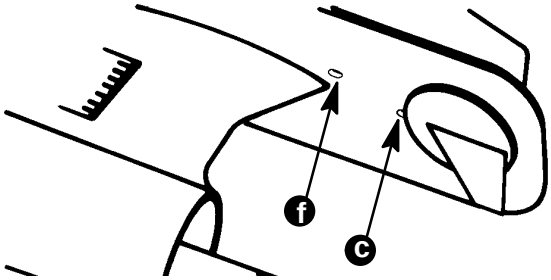
75018

a - Drain Plug (Cool Fuel System - Fuel Cool System)
b - Drain Plug (Water Tube - Carburetor Models)

9. Insert a small wire (repeatedly) to make sure that vent holes and water drain holes and passages (as shown) are unobstructed and open.



71216



70134

a - Speedometer Pitot Tube
b - Trim Tab Cavity Vent Hole
c - Trim Tab Cavity Drain Passage
d - Gear Housing Water Drain Hole (One Each - Port and Starboard
e - Gear Housing Cavity Vent Hole
f - Gear Housing Cavity Drain Hole

10. Crank engine over SLIGHTLY, with starter motor, to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.

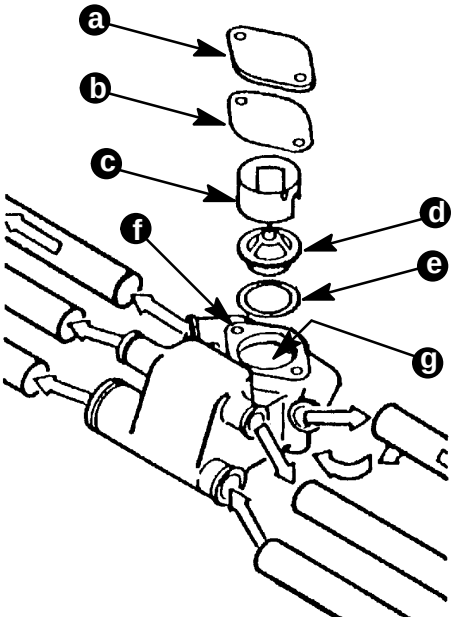
⚠CAUTION

If boat is in the water or is to remain in the water, seacock (if so equipped) must remain closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a seacock, seawater inlet hose must remain disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the seawater inlet hose reconnected prior to starting the engine.

11. After cooling system has been drained completely, coat threads of drain plugs with Quicksilver Perfect Seal and reinstall. Tighten drain plugs securely. Reconnect hoses and tighten all hose clamps securely. **If NOT equipped with seacock:** seawater inlet hose must remain disconnected and plugged until engine is to be restarted.

IMPORTANT: MerCruiser recommends that propylene glycol antifreeze (nontoxic and biodegradable, which makes it friendly to lakes and rivers) be used in sea-water section of the cooling system for cold weather or extended storage. Make sure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

12. For additional assurance against freezing and rust, remove the thermostat cover and thermostat. Fill the engine seawater cooling system with a mixture of antifreeze and tap water mixed to manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during cold weather or extended storage. Using a new gasket, reinstall thermostat and cover. Tighten cover bolts to 30 lb. ft. (41 N·m).

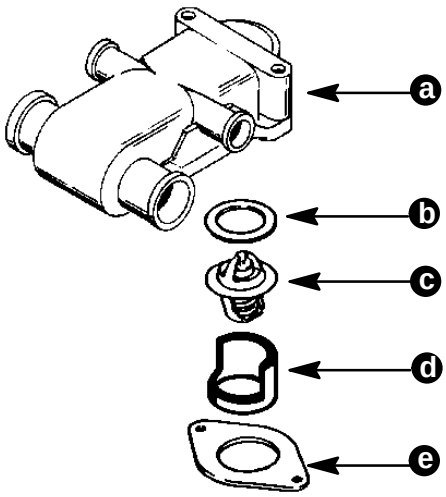


72589

6 - Hole Thermostat Housing

a - Cover
b - Gasket
c - Spacer
d - Thermostat
e - O-Ring
f - Housing
g - Fill Here

NOTE: *Hoses shown removed only to indicate flow. Do not remove hoses.*



74493

4 - Hole Thermostat Housing

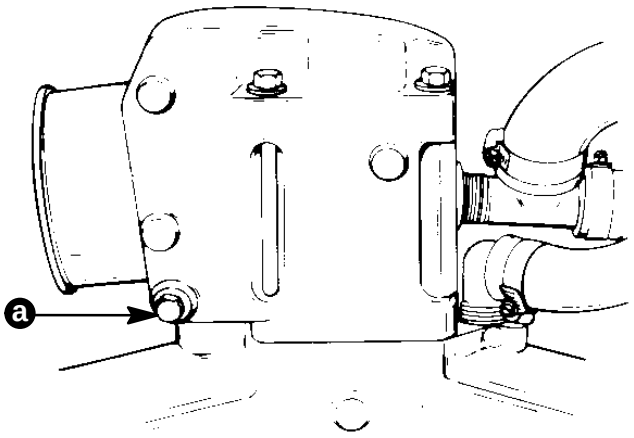
a - Thermostat Housing
b - Rubber Gasket
c - Thermostat
d - Diverter
e - Gasket

Draining Seawater Section of Closed Cooled (Coolant) Models

NOTICE
Refer to "Cold Weather or Extended Storage," "Precautions," in this section, BEFORE proceeding.

1. Close seacock (if so equipped) or disconnect and plug seawater inlet hose.
2. Check that engine is as level as possible to ensure complete draining of cooling system.

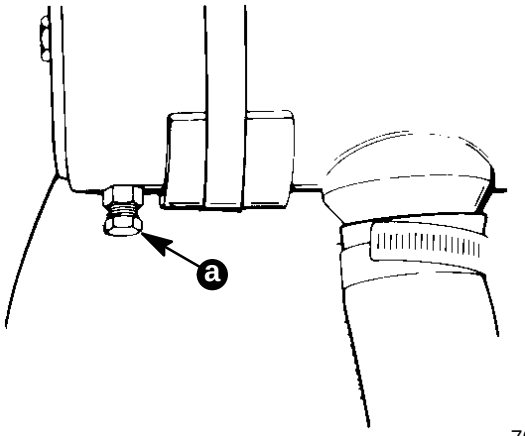
3. If equipped, remove drain plugs from port and starboard exhaust elbows.



71330

a - Drain Plug (Port and Starboard)

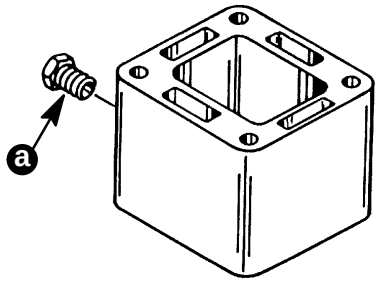
4. Remove drain plug from heat exchanger.



70583

a - Drain Plug

5. If equipped with 3 in. (76 mm) or 6 in. (152 mm) risers, remove drain plug as shown from port and starboard risers.



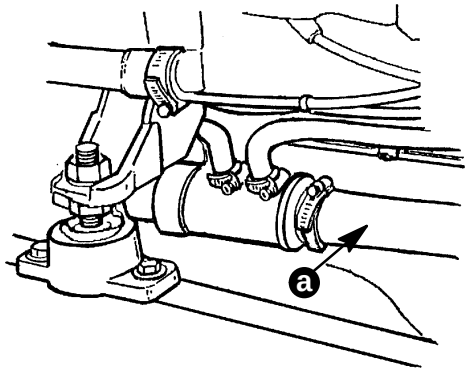
73175

b - Drain Plug (Removed)

6. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses are disconnected.*

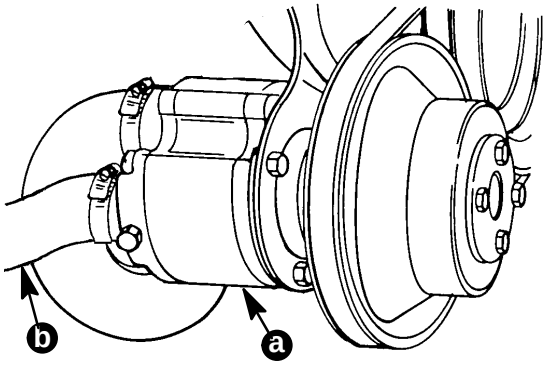
7. Remove the power steering fluid cooler seawater hose, as shown.



72588

a - Hose, Seawater Pump to Cooler

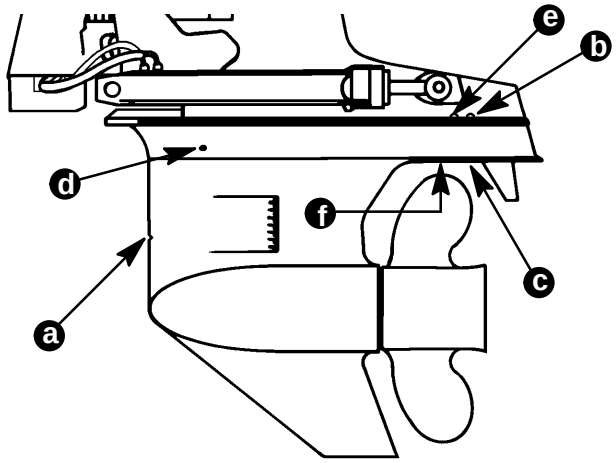
8. Remove belt driven seawater pump inlet hose as shown (if so equipped).



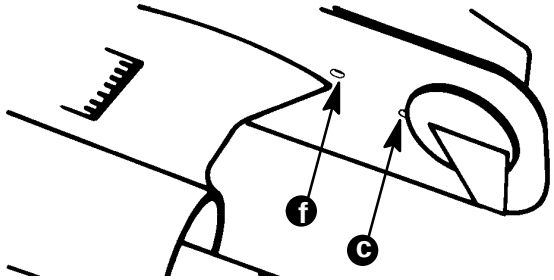
72532

a - Seawater Pickup Pump
b - Seawater Inlet Hose

9. Insert a small wire (repeatedly) to make sure that vent holes and water drain holes and passages (as shown) are unobstructed and open.



71216



70134

a - Speedometer Pitot Tube
b - Trim Tab Cavity Vent Hole
c - Trim Tab Cavity Drain Passage
d - Gear Housing Water Drain Hole (One Each - Port and Starboard
e - Gear Housing Cavity Vent Hole
f - Gear Housing Cavity Drain Hole

10. Crank engine over SLIGHTLY with starter motor to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.

⚠CAUTION

If boat is in the water or is to remain in the water, seacock (if so equipped) must remain closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a seacock, seawater inlet hose must remain disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the seawater inlet hose reconnected prior to starting the engine.

11. After seawater section of cooling system has been drained completely, coat threads of drain plugs with Quicksilver Perfect Seal and reinstall. Tighten drain plugs securely. Reconnect hoses and tighten all hose clamps securely. **If NOT equipped with seacock:** seawater inlet hose must remain disconnected and plugged until engine is to be restarted.

Recommissioning

NOTICE
Refer to "Cold Weather or Extended Storage," "Precautions," in this section, BEFORE proceeding.

1. Check that all cooling system hoses are connected and tight and all petcocks and drain plugs are installed and tight.
2. **If equipped with seacock:** Open seacock.
3. Inspect all drive belts.
4. Perform all lubrication and maintenance specified for completion "At Least Once Yearly" in maintenance chart, except items which were performed at time of engine layup.
5. For drive unit, refer to appropriate stern drive manual.

⚠CAUTION

When installing battery (in next step), be sure to connect POSITIVE battery cable to POSITIVE (+) battery terminal FIRST, and NEGATIVE (–) battery cable to NEGATIVE (–) battery terminal LAST. If battery cables are reversed, or connection order is reversed, damage to electrical system WILL result.

6. Install fully charged battery. Clean battery cable clamps and terminals to help retard corrosion.
7. Start engine and closely observe instrumentation to ensure that all systems are functioning properly.
8. Carefully inspect entire engine for fuel, oil, water and exhaust leaks.
9. Check fuel pump sight tube.
10. Check steering system and shift and throttle controls for proper operation.

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

Cause	Special Information
1. Moisture on ignition components	1. Distributor cap or spark plug wires arcing
2. Battery, electrical connections, damaged wiring	
3. Ignition switch	
4. Shift interrupter switch (Alpha One Models Only)	
5. Shorted tachometer	5. Disconnect tachometer and try again
6. Ignition timing	
7. Spark plugs	7. Fouled, burned, cracked porcelain
8. Spark plug wires	8. Faulty insulation, broken wires
9. Cracked or dirty distributor cap	
10. Faulty ignition components	10. Check components
11. Engine synchronizer (if equipped) hooked up in series on purple ignition wire (dual engines only)	11. Synchronizers must be hooked up directly at coil terminal (parallel chute)

TROUBLESHOOTING

Table of Contents

	Page
Precautions	1C-1
Used Spark Plug Analysis	1C-1
Spark Plug Analysis	1C-2
Normal Condition	1C-2
Chipped Insulator	1C-2
Wet Fouling (Oil Deposits)	1C-3
Cold Fouling	1C-3
Overheating	1C-4
High Speed Glazing	1C-4
Scavenger Deposits	1C-4
Pre-Ignition Damage	1C-4
Reversed Coil Polarity	1C-5
Splashed Deposits	1C-5
Mechanical Damage	1C-5
Poor Boat Performance and/or Poor Maneuverability	1C-6
Improper Full Throttle Engine RPM	1C-7
RPM Too High	1C-7
RPM Too Low	1C-7
Engine Cranks Over But Will Not Start Or Is Hard To Start	1C-8
Important Information	1C-8
Thunderbolt IV and V Ignition (No Spark)	1C-8
Testing Thunderbolt IV System	1C-9
Testing Thunderbolt V Ignition System	1C-10
Fuel System Rich	1C-11
Fuel System Lean	1C-11
Miscellaneous	1C-11
Engine Will Not Crank Over/Starter Inoperative	1C-12

	Page
Charging System Inoperative	1C-12
Noisy Alternator	1C-13
Instrumentation Malfunction	1C-13
Radio Noise	1C-13
Poor Fuel Efficiency	1C-14
Carburetor Malfunction	1C-15
Carburetor Malfunction (continued)	1C-16
Engine Runs Poorly At Idle	1C-17
Engine Acceleration Is Poor	1C-18
Engine Runs Poorly At High RPM	1C-19
Troubleshooting With Vacuum Gauge	1C-20
Engine Noise	1C-21
Important Information	1C-21
Valve Cover Area	1C-21
Cylinder Area	1C-21
Camshaft Area	1C-22
Crankshaft Area	1C-22
Miscellaneous	1C-23
Oil Pressure	1C-24
Low Oil Pressure	1C-25
High Oil Pressure	1C-25
Excessive Oil Consumption	1C-26
Water in Engine	1C-27
Important Information	1C-27
Water In Crankcase	1C-27
Water On Top Pistons	1C-28
Engine Overheats (Mechanical)	1C-29
Engine Overheats (Cooling System)	1C-30
Insufficient Water Flow From Belt Driven Seawater Pump	1C-31
Power Steering	1C-32
Poor, Erratic, or No Assist	1C-32
Noisy Pump	1C-33
Fluid Leaks	1C-33

Precautions

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak. Follow specific procedure, given in Section 5A of this manual, for all fuel line connections.

⚠WARNING

Make sure no fuel leaks exist before closing engine hatch.

⚠CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage may result.

⚠CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump on engine, or pump impeller may be damaged and subsequent overheating damage to engine may result. Engine may be operated with boat out of water, if instructions under "Running Engine with Boat Out of Water," following, are completed.

⚠WARNING

When running engine with boat out of water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that the propeller be removed.

⚠CAUTION

DO NOT run engine above 1500 RPM, as suction created by seawater pickup pump may collapse water supply hose and cause engine to overheat.

⚠WARNING

Be sure that engine compartment is well ventilated and that no gasoline vapors are present to prevent the possibility of a FIRE or EXPLOSION.

⚠WARNING

DO NOT leave helm unattended while performing idle speed adjustment.

Used Spark Plug Analysis

Use the following illustrations for determining serviceability of spark plug. Spark plug condition also can suggest a variety of possible engine malfunctions and, therefore, can indicate needed engine repairs. When old plugs are replaced, replace entire set. Perform plug service only on those plugs suitable for additional service, using the following procedures:

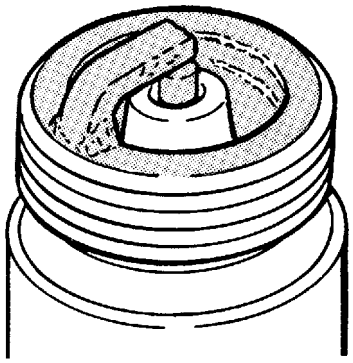
1. Remove any oil deposits with solvent and dry plugs thoroughly.
2. Open electrode gap wide enough to permit cleaning and filing.
3. Remove combustion deposits from firing end of spark plug with a plug cleaner. Blow off with compressed air to remove abrasives.
4. File electrode surfaces to restore clean, sharp edges. Again remove filings with compressed air.

5. Reset gap to specifications by bending only side electrode with proper tool.

Spark Plug Analysis

Normal Condition

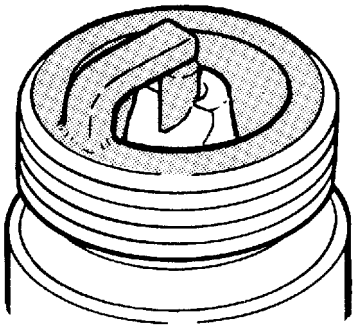
Few deposits are present and probably will be light tan or gray in color. This plug shows that plug heat range is compatible with engine, and engine is electrically and mechanically in good running condition. With proper plug servicing (clean, file and re-gap), this plug can be reinstalled with good results.



72420

Chipped Insulator

Chipped insulator usually results from careless plug re-gapping. Under certain conditions, severe detonation also can split insulator firing ends. Plug must be replaced.

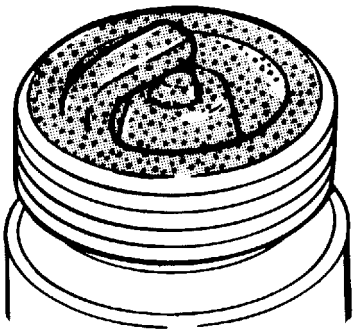


72420

Wet Fouling (Oil Deposits)

Plug becomes shorted by excessive oil entering combustion chamber, usually in engine with many hours of operation. Worn piston rings, cylinder walls, valve guides or valve stem seals are causes of oil entering combustion chamber. Only engine repairs will permanently relieve oil wet fouling.

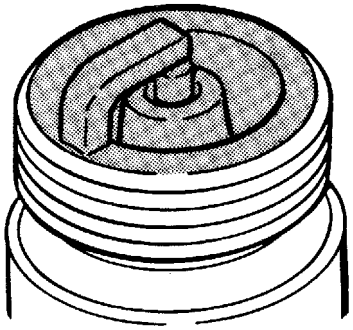
IMPORTANT: New engines or recently overhauled engines may wet foul plugs before normal oil control is achieved with proper break-in procedures. Such fouled plugs may be serviced (clean, file and re-gap) and reinstalled.



72420

Cold Fouling

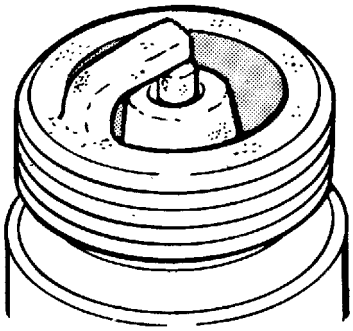
Dry, black deposits indicate rich fuel mixture or weak ignition. Clogged flame arrestor, flooding carburetor, sticky choke or weak ignition components all are probable causes. If, however, only one or two plugs in set are fouled, check for sticking valves or bad ignition leads. After correcting cause, service (clean, file and re-gap) plugs and reinstall.



72421

Overheating

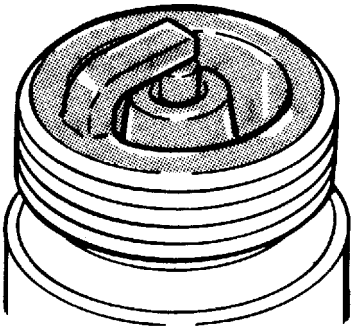
Insulator is dull white or gray and appears blistered. Electrodes are eroded and there is an absence of deposits. Check that correct plug heat range is being used. Also check for over-advanced ignition timing, cooling system malfunction, lean fuel/air mixtures, leaking intake manifold or sticking valves. Replace spark plugs.



72421

High Speed Glazing

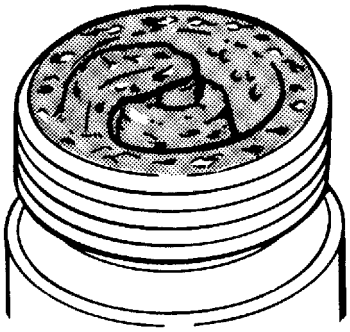
Insulator has yellowish, varnish-like color, indicating that temperatures suddenly have risen, usually during hard, fast acceleration under heavy load. Normal deposits do not get a chance to blow off. Instead, they melt and form a conductive coating. Replace plugs. If condition recurs, use colder heat range plug and service plugs more frequently.



72421

Scavenger Deposits

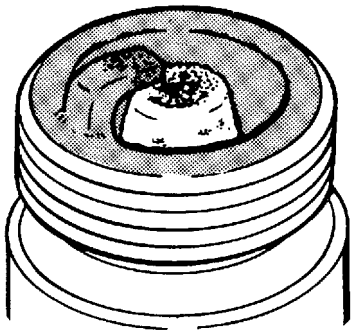
Powdery white or yellow deposits are built up on shell, insulator and electrodes. This is normal appearance with certain branded fuels. Accumulation on ground electrodes and shell areas may be unusually heavy, but may be easily chipped off. Plugs can be serviced (clean, file and re-gap) and reinstalled.



72422

Pre-Ignition Damage

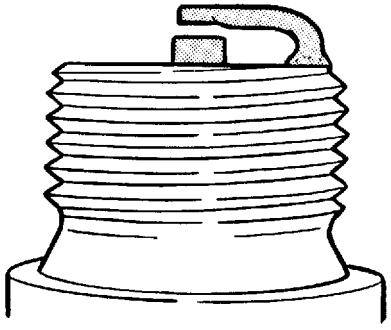
Pre-ignition damage is caused by excessive high temperatures. Center electrode melts first, followed by ground electrode. Normally, insulators are white but may be dirty if plug has been misfiring. Check for correct plug heat range, advanced ignition timing, lean fuel mixture, incorrect fuel used, malfunctioning cooling system, leaking intake manifold or lack of lubrication.



72422

Reversed Coil Polarity

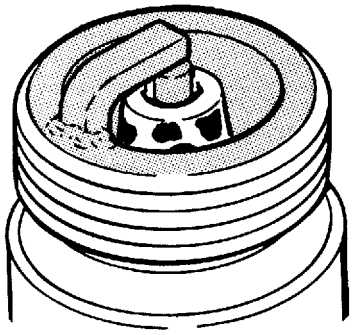
Concave erosion of ground electrode is an indication of reversed polarity. Center electrode will show only normal wear. Engine will misfire and idle rough. To correct, reverse primary coil leads. Replace spark plugs.



72422

Splashed Deposits

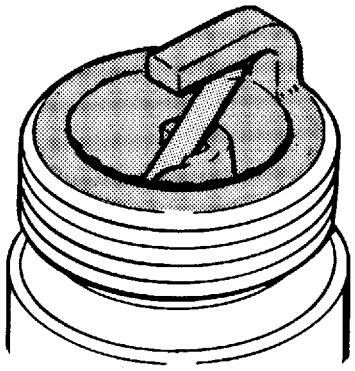
Spotted deposits, which sometimes occur after long delayed tune-up, accumulate after a long period of misfiring. When normal combustion temperatures are restored, upon installation of new plugs, deposits loosen from top of piston and head and are thrown against hot insulator. Clean and service plugs and re-install.



72423

Mechanical Damage

Mechanical damage to spark plug firing end is caused by foreign object in combustion chamber. Because of valve overlap, small objects can travel from one cylinder to another. Check all cylinders, intake manifold and exhaust material to prevent further damage.



72423

IMPORTANT: When working on engine, spark plug holes and carburetor throat should be kept covered to prevent foreign objects from entering combustion chamber.

Poor Boat Performance and/or Poor Maneuverability

Symptom	Cause
Bow too low	A. Improper drive unit trim angle
	B. Improper weight distribution
	C. Boat is underpowered
	D. Permanent or power hook in boat bottom
	E. False bottom full of water
	F. Improperly adjusted trim tabs (after planes)
	G. Dirty boat bottom (marine growth)
Bow too high	A. Improper drive unit trim angle
	B. Propeller pitch too great
	C. Dirty boat bottom (marine growth)
	D. Poor running engine
	E. Improper weight distribution
	F. Rocker in boat bottom
	G. False bottom full of water
	H. Improperly adjusted trim tabs (after planes)
Propeller ventilating	A. Drive unit installed too high on transom
	B. Dirty or rough boat bottom
	C. Damaged propeller; pitch too small; diameter too small
	D. Keel located too close to propeller or too deep in the water
	E. Water pickup or thru hull fittings located too close to propeller
	F. Hook in boat bottom
	G. Propeller plugged up with weeds

Improper Full Throttle Engine RPM

RPM Too High

Cause	Special Information
Propeller	Damaged; pitch too low; diameter too small; propeller hub slipping.
Boat	Water pickup or thru hull fittings mounted too close to propeller (ventilation); keel located too close to propeller and/or too deep in the water (ventilation). Drive installed too high on transom; wrong gear ratio.
Operation	Unit trimmed out too far.
Engine coupler slipping	

RPM Too Low

Cause	Special Information
Propeller	Damaged; pitch too great; diameter too great.
Boat	Dirty or damaged bottom; permanent or power hook in bottom; false bottom full of water. Drive installed too low on transom; wrong gear ratio.
Operation	Unit trimmed in too far.

Engine Cranks Over But Will Not Start Or Is Hard To Start

Important Information

1. First, determine which engine system is causing the problem. To make an engine run, basic components fuel, spark (ignition), and compression are required. If all three components are present, the engine should run. If any one of the three are missing, weak, or arriving at the wrong time the engine will not run.
2. Determine if there is fuel present by looking down the carburetor venturi while actuating throttle. There should be a stream of fuel coming out of the accelerator pump nozzles if the carburetor has fuel.
3. Check ignition system operation. Remove coil wire from tower on distributor cap. Hold coil wire near ground and check for spark while cranking engine over. Repeat procedure with spark plug wires. If there is spark at the spark plug wires, remove the spark plugs and make sure they are correct type and heat range, and not fouled or burned.
4. Run a compression check on engine to make sure the engine is mechanically sound.

Thunderbolt IV and V Ignition (No Spark)

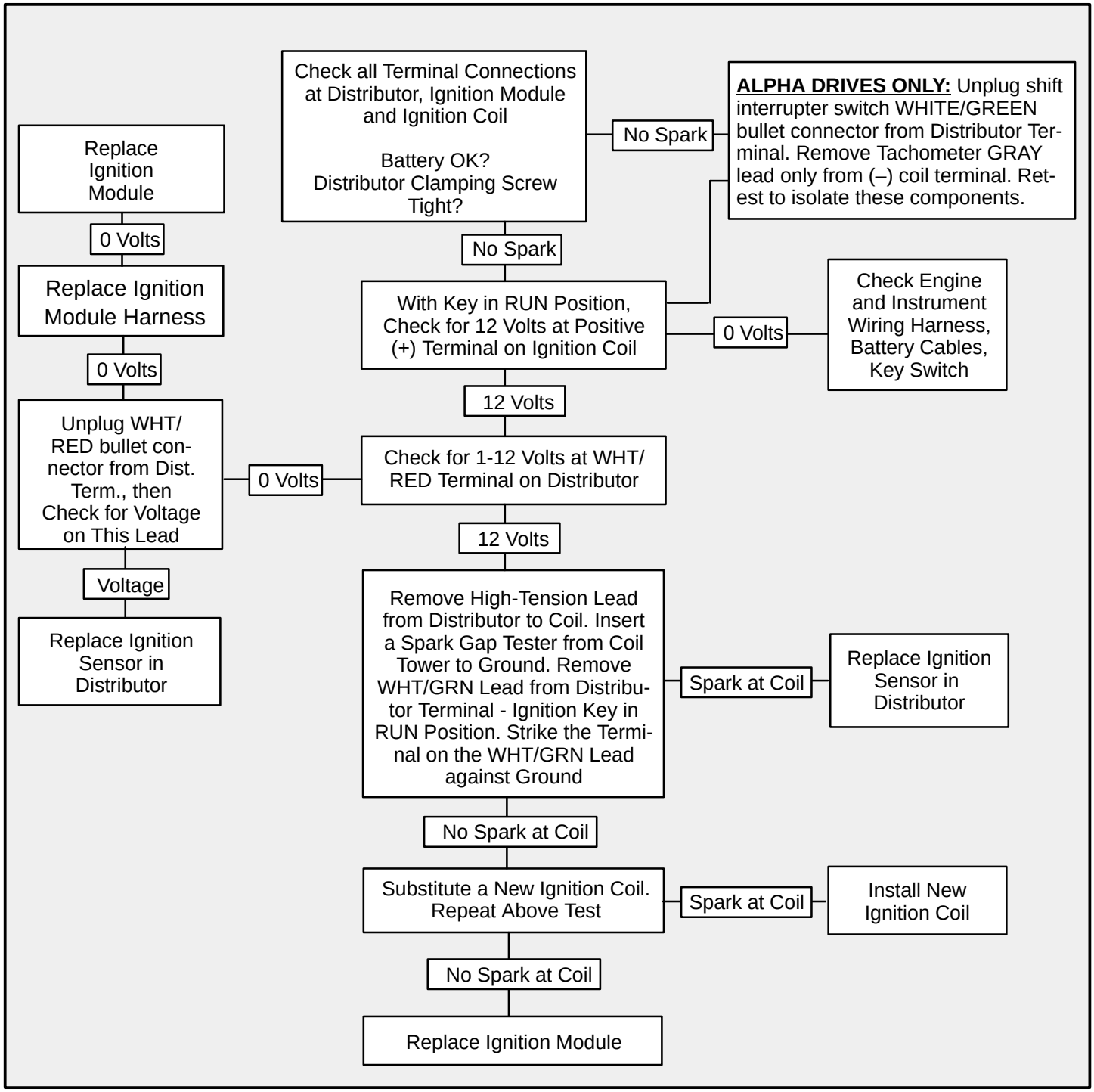
Cause	Special Information
Moisture on ignition components	Distributor cap or spark plug wires arcing
Battery, electrical connections, damaged wiring	
Ignition switch	
Shift interrupter switch (Alpha One Models Only)	
Shorted tachometer	Disconnect tachometer and try again
Ignition timing	
Spark plugs	Fouled, burned, cracked porcelain
Spark plug wires	Faulty insulation, broken wires
Cracked or dirty distributor cap	
Faulty ignition components	Check components
Engine synchronizer (if equipped) hooked up series on purple ignition wire (dual engines only)	Synchronizers must be hooked up directly coil terminal (parallel chute)

Testing Thunderbolt IV System

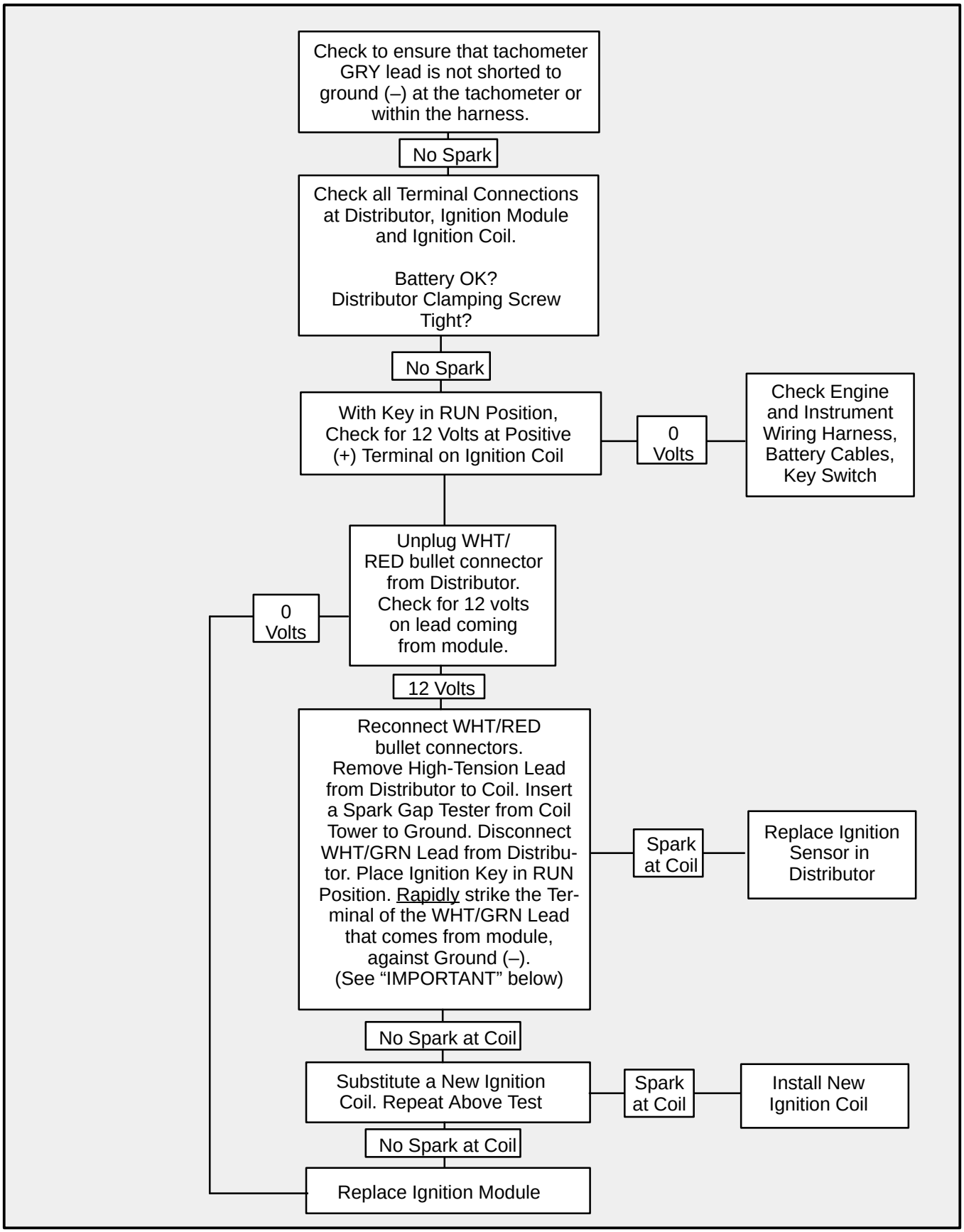
⚠WARNING

Be sure that engine compartment is well ventilated and that there are no gasoline vapors present during the following test to prevent a potential fire hazard.

IMPORTANT: Use a voltmeter when making these tests. DO NOT use a test light.


Check all Terminal Connections at Distributor, Ignition Module and Ignition Coil
Battery OK? Distributor Clamping Screw Tight?
No Spark
ALPHA DRIVES ONLY: Unplug shift interrupter switch WHITE/GREEN bullet connector from Distributor Terminal. Remove Tachometer GRAY lead only from (–) coil terminal. Retest to isolate these components.
No Spark
With Key in RUN Position, Check for 12 Volts at Positive (+) Terminal on Ignition Coil
0 Volts
Check Engine and Instrument Wiring Harness, Battery Cables, Key Switch
12 Volts
Check for 1-12 Volts at WHT/RED Terminal on Distributor
0 Volts
Unplug WHT/RED bullet connector from Dist. Term., then Check for Voltage on This Lead
Voltage
Replace Ignition Sensor in Distributor
0 Volts
Replace Ignition Module Harness
0 Volts
Replace Ignition Module
12 Volts
Remove High-Tension Lead from Distributor to Coil. Insert a Spark Gap Tester from Coil Tower to Ground. Remove WHT/GRN Lead from Distributor Terminal - Ignition Key in RUN Position. Strike the Terminal on the WHT/GRN Lead against Ground
Spark at Coil
Replace Ignition Sensor in Distributor
No Spark at Coil
Substitute a New Ignition Coil. Repeat Above Test
Spark at Coil
Install New Ignition Coil
No Spark at Coil
Replace Ignition Module

Testing Thunderbolt V Ignition System


Check to ensure that tachometer GRY lead is not shorted to ground (–) at the tachometer or within the harness.
No Spark
Check all Terminal Connections at Distributor, Ignition Module and Ignition Coil.
Battery OK?
Distributor Clamping Screw Tight?
No Spark
With Key in RUN Position, Check for 12 Volts at Positive (+) Terminal on Ignition Coil
0 Volts
Check Engine and Instrument Wiring Harness, Battery Cables, Key Switch
Unplug WHT/ RED bullet connector from Distributor. Check for 12 volts on lead coming from module.
0 Volts
12 Volts
Reconnect WHT/RED bullet connectors. Remove High-Tension Lead from Distributor to Coil. Insert a Spark Gap Tester from Coil Tower to Ground. Disconnect WHT/GRN Lead from Distributor. Place Ignition Key in RUN Position. Rapidly strike the Terminal of the WHT/GRN Lead that comes from module, against Ground (–). (See “IMPORTANT” below)
Spark at Coil
Replace Ignition Sensor in Distributor
No Spark at Coil
Substitute a New Ignition Coil. Repeat Above Test
Spark at Coil
Install New Ignition Coil
No Spark at Coil
Replace Ignition Module

IMPORTANT: The WHT/GRN lead must be touched against ground (–) 2-3 times per second to simulate a running engine. Repeat this test several times to ensure that spark is present.

Fuel System Rich

NOTE: *The following fuel system diagnosis refer primarily to the carbureted engines. For additional information pertaining to fuel injection refer to Section 5D of this manual.*

Cause	Special Information
Warm engine carburetor percolation	Fuel boils out of float bowl when shut off and warm. Floods intake manifold.
Clogged flame arrestor	
Automatic choke not opening	
Float adjustment	
Float leaks or is saturated with fuel	
Needle and seat leaking	
Carburetor gaskets leaking	
Excessive fuel pump pressure	
Cracked or porous carburetor body	Unseats needle and seat

Fuel System Lean

Cause	Special Information
Empty fuel tank	
Fuel shut-off valve closed (if equipped)	
Vapor lock	Engine will not start after warm engine shut down
Automatic choke	Stuck open, wrong adjustment

Miscellaneous

Cause	Special Information
1. Low grade or stale fuel	
2. Water in fuel	

Engine Will Not Crank Over/Starter Inoperative

Cause	Special Information
Remote control lever not in neutral position	
Battery charge low; damaged wiring; loose electrical connections	
Circuit breaker tripped	
Blown fuse	
Ignition switch	
Slave solenoid	
Faulty neutral start safety switch	Open circuit
Starter solenoid	
Starter motor	
Mechanical engine malfunction	

Charging System Inoperative

Cause	Special Information
Loose or broken drive belt	
Engine RPM too low on initial start	Rev engine to 1500 RPM
Loose or corroded electrical connections	
Faulty battery gauge	Best way to test is to replace gauge
Battery will not accept charge	Low electrolyte or failed battery
Faulty alternator or regulator	
Refer to Section 4C for complete “Charging System” diagnosis procedures	

Noisy Alternator

Cause	Special Information
Loose mounting bolts Drive belt Loose drive pulley Worn or dirty bearings Faulty diode trio or stator	Worn, frayed, loose

Instrumentation Malfunction

Cause	Special Information
Faulty wiring, loose or corroded terminals	
Faulty key switch	Test, as outlined in Section 4D
Faulty gauge	Test, as outlined in Section 4D
Faulty sender	Test , As outlined in Section 4D

Radio Noise

Cause	Special Information
A “popping” noise that will increase with engine RPM. Noise will stop as soon as engine is turned off.	Ignition System - wrong spark plugs; cracked distributor cap; cracked coil tower; leaking spark plug wires; moisture on ignition components
“High pitched whine” in the radio	Alternator - poor brush contact on the slip rings
A “hissing or crackling” noise when instruments are jarred with ignition on	Instrumentation - loose connections, or antennae wire routed too close to instruments
Varying unexplained noises	Accessories - bilge pump, bilge blower; fish finder, depth locator; cabin heater motor, etc. Dis connect one at a time until noise disappears.

Poor Fuel Efficiency

Cause	Special Information
Fuel leaks	
Operator habits	Prolonged idling; slow acceleration; failure to cut back on throttle once boat is on plane; boat over loaded; uneven weight distribution
Engine laboring	Bent, damaged, or wrong propeller. Water test boat for proper operating RPM at wide open throttle
Clogged flame arrestor	
Engine compartment sealed too tight	Not enough air for engine to run properly
Boat bottom	Dirty (marine growth), hook, rocker
Carburetor	Idle mixture settings, accelerator pump adjustments,linkage binding, choke adjustment, carburetor flooding over, main fuel jets
Improper fuel	
Crankcase ventilation system not working	
Engine needs tune-up	
Engine running too cold or too hot	
Plugged or restricted exhaust	
Engine	Low compression

Carburetor Malfunction

Symptoms	Cause
Flooding	A. Needle and seat
	B. Float adjustment
	C. Saturated float
	D. Gaskets leaking
	E. Cracked fuel bowl
	F. Fuel percolation
	G. Automatic choke
Rough idle	A. Idle RPM too low
	B. Idle mixture screws
	C. Idle passages dirty
	D. Throttle valves not closing
	E. Engine flooding
	F. Vacuum leak
	G. Throttle body heat passages plugged
Hesitation or acceleration flatness	A. Accelerator pump
	B. Leaking gaskets
	C. Automatic choke
	D. Power piston or power valve
	E. Throttle valves
	F. Throttle body heat passages plugged
	G. Main metering jets
	H. Float adjustment
	I. Secondary air valve wind-up

Carburetor Malfunction (continued)

Symptoms	Cause
Engine surges	A. Main metering jets
	B. Leaking gaskets
	C. Float adjustment
	D. Saturated float
	E. Power piston or valve
	F. Throttle valves
Low top speed or lack of power	A. Power piston or valve
	B. Float adjustment
	C. Main metering jets
	D. Leaking gaskets
Poor cold engine operation	A. Idle RPM too low
	B. Idle mixture screws
	C. Throttle valves
	D. Automatic choke
	E. Engine flooding
Engine stalls	A. Idle RPM too low
	B. Idle mixture screws
	C. Engine flooding
	D. Automatic choke
	E. Dirt in carburetor
	F. Accelerator pump
	G. Leaking gaskets
Hard starting	Refer to “Engine Starts Hard”

Engine Runs Poorly At Idle

Cause	Special Information
Clogged flame arrestor	
Improper idle fuel mixture adjustment	
Engine floods at idle	A. Problem in ignition system causing the engine to run rough
	B. Idle mixture screw adjusted incorrectly
	C. Bad needle and seat
	D. Incorrect float level drop
	E. If carburetor (2 bbl. only) has a solid needle, replace with a spring loaded needle
Moisture on ignition components	Cap or spark plug wires arcing
Water in fuel	
Low grade or stale fuel	
Incorrect ignition timing	
Automatic choke	
Spark plugs	Fouled, burned, cracked porcelain
Spark plug wires	Insulation breakdown, wires broken
Defective coil Cracked or dirty distributor cap	
Incorrect float level	
Dirty carburetor	
Vacuum leak	Leak at manifold or carburetor base
Incorrect fuel pump pressure	Too low - can't supply the carburetor Too high - unseats the needle and seat
Low compression	Also check for blown head gasket
Loose or worn distributor	Timing changes
Water leaking into cylinders	Head gasket, exhaust manifold, cracked head or valve seat
Loose or broken engine mounts	

Engine Acceleration Is Poor

Cause	Special Instructions
Also refer to “Poor Boat Performance”	
Idle mixture screws	
Incorrect ignition timing	
Incorrect distributor or amplifier advance curve	Refer to Section 4B
Accelerator pump	Check for stream of raw fuel from accelerator pump discharge nozzle, when opening throttle with engine shut off
Cracked or dirty distributor cap or rotor	
Vacuum leak	Intake manifold or carburetor base
Spark plugs	Fouled, burned; wrong heat range; cracked porcelain
Float adjustment	
Dirty carburetor	
Low compression	

Engine Runs Poorly At High RPM

Cause	Special Information
Also refer to “Poor Boat Performance”	
Crankcase overfilled with oil	Check oil level with boat at rest in the water.
Anti-siphon valve (if equipped)	Restricting fuel supply
Plugged fuel tank vent	
Fuel supply	Refer to “Carburetor Malfunctions” (See “Table of Contents”)
Ignition timing	
Low grade of fuel or water in the fuel	
Spark plugs	Fouled, burned, cracked porcelain, incorrect heat range
Spark plug wires	Poor insulation, broken wires
Distributor cap or rotor	Dirty or cracked
Coil	
Distributor	Excessive play in shaft
Engine overheating	Refer to “Engine Overheats”
Low compression	Worn valves, rings, cylinders, etc.
Restricted exhaust	

Troubleshooting With Vacuum Gauge

Reading	Cause
Steady reading between 15-21 inches at idle RPM	Normal
Extremely low reading, but steady at idle RPM	Vacuum leak; incorrect timing; underpowered boat; faulty boat bottom
Fluctuates between high and low at idle RPM	Blown head gasket between two adjacent cylinders
Fluctuates 4 or 5 inches very slowly at idle RPM	Carburetor needs adjustment; spark plug gap too narrow;valves are sticking
Fluctuates rapidly at idle, steadies as RPM is increased	Valve guides are worn
Continuously fluctuates between low and normal reading at regular intervals at idle RPM	Burned or leaking valve

Engine Noise

Important Information

No definite rule or test will positively determine source of engine noise; therefore, use the following information only as a general guide to engine noise diagnosis.

1. Use a timing light to determine if noise is timed with engine speed or one-half engine speed. Noises timed with engine speed are related to crankshaft, rods, pistons, piston pins, and flywheel. Noises timed to one-half engine speed are valve train related.
2. The use of a stethoscope can aid in locating a noise source; however, because noise will travel to other metal parts not involved in the problem, caution must be exercised.
3. If you believe noise is confined to one particular cylinder, ground spark plug leads, one at a time. If noise lessens noticeably or disappears, it is isolated to that particular cylinder.
4. Try to isolate the noise to location in engine: front to back, top to bottom. This can help determine which components are at fault.
5. Sometimes noises can be caused by moving parts coming in contact with other components. Examples are: flywheel or coupler; exhaust flappers rattling against exhaust pipe; crankshaft striking (pan, pan baffle, or dipstick tube); rocker arm striking valve cover; and loose flywheel cover. In many cases if this is found to be the problem, a complete engine teardown is not necessary.
6. When noise is isolated to a certain area and component, removal and inspection will be required. Refer to proper sections of service manual for information required for service.
7. If noise cannot be distinguished between engine and drive unit, remove drive from boat. Run a water supply directly to engine. Run engine without the drive to determine if noise is still there.

Valve Cover Area

Location	Possible Cause
Valve cover area, timed to one-half engine speed, noise could be confined to one cylinder or may be found in any multitude of cylinders	A. Rocker arm striking valve cover
	B. Rocker arm out of adjustment
	C. Worn rocker arm
	D. Bent push rod
	E. Collapsed filter

Cylinder Area

Location	Possible Causes
Cylinder area, may be confined to one cylinder or found in more than one cylinder, timed to engine speed	A. Sticking valve
	B. Carbon build-up
	C. Connecting rod installed wrong
	D. Bent connecting rod
	E. Piston
	F. Piston rings
	G. Piston pin
	H. Cylinder worn

Camshaft Area

Location	Possible Causes
Camshaft area, front of engine, timed to one half engine speed	A. Crankshaft timing sprocket
	B. Timing chain
	C. Fuel Pump
	D. Valve Lifter
	E. Cam Bearings
Camshaft area, center of engine, timed to one half engine speed	A. Fuel Pump
	B. Valve Lifter
	C. Cam bearing
Camshaft area, rear of engine, timed to one half engine speed	A. Distributor gear
	B. Valve lifter
	C. Cam bearings
Camshaft area, throughout engine, timed to one half engine speed	A. Loss of oil pressure
	B. Valve lifters
	C. Cam bearings

Crankshaft Area

Location	Possible Causes
Crankshaft area, front of engine, timed to engine speed	A. Crankshaft timing sprocket
	B. Timing chain
	C. Main bearing
	D. Rod bearing
Crankshaft area, center of engine, timed to engine speed	A. Crankshaft striking pan or pan baffle
	B. Main bearing
	C. Rod bearing
Crankshaft area, rear of engine, timed to engine speed	A. Loose flywheel cover
	B. Loose coupler
	C. Loose flywheel
	D. Main bearing
	E. Rod bearing
Crankshaft area, throughout engine, timed to engine speed	A. Loss of oil pressure
	B. Main bearings
	C. Rod bearings

Miscellaneous

Noise	Possible Cause
Engine spark knock	A. Advanced timing
	B. Low octane fuel
	C. Engine running hot
	D. Carbon deposits in engine
Popping through carburetor	A. Wrong ignition timing
	B. Carburetor set too lean
	C. Faulty accelerator pump
	D. Vacuum leak
	E. Valve adjustment
	F. Valve timing
	G. Burned or stuck valve
Hissing	A. Vacuum leak
	B. Leaking exhaust (manifolds or pipes)
	C. Loose cylinder heads
	D. Blown head gasket
Whistle	A. Vacuum leak
	B. Dry or tight bearing in an accessory
Sparks jumping	A. Leaking high tension lead
	B. Cracked coil tower
	C. Cracked distributor cap
Squeaks or squeals	A. Drive belt slipping
	B. Dry or tight bearing in an accessory
	C. Parts rubbing together
Rattling in exhaust pipe area	A. Exhaust shutters

Oil Pressure

Cause	Special Information
Measuring oil pressure	Use a good automotive oil pressure test gauge. Do not rely on the oil pressure gauge in the boat.
Check engine oil level with boat at rest in the water	Oil level should be between the ADD and FULL marks
Oil level in crankcase above FULL mark	May cause loss of engine RPM, oil pressure gauge fluctuation, drop in oil pressure, and hydraulic valve lifter noise at high RPM
Oil level in crankcase below ADD mark	Low oil pressure; oil pressure gauge fluctuation; internal engine noise and/or damage
Change in oil pressure	This may be a normal condition. Oil pressure may read high in the cooler times of the day, and when engine is not up to operating temperature. As the air temperature warms up and engine is running at normal opening temperature, it is normal for oil pressure to drop.
Low engine oil pressure at idle	With modern engines and engine oils, low oil pressure readings at idle do not necessarily mean there is a problem. If valve lifters do not “clatter” (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and, also, the oil will thinout somewhat from heat.
Low engine oil pressure at idle after running at a high RPM	Refer to No. 5 and 6, preceding
Boats with dual engines	It is not uncommon to see different oil pressure readings between the two engines, as long as both engines fall within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders, etc.
Boats with dual stations	Refer to No. 8. preceding

Low Oil Pressure

Cause	Special Information
Low oil level in crankcase	
Defective oil pressure gauge and/or sender	Verify with an automotive test gauge. Refer to Section 4D for instrument testing.
Thin or diluted oil	Oil broken down; contains water or gas; wrong viscosity; engine running too hot or too cold; excessive idling in cold water (condensation)
Oil pump	Relief valve stuck open; pickup tube restricted; worn parts in oil pump; air leak on suction side of oil pump or pickup oil tube
Oil leak can be internal or external	Oil passage plugs leaking, cracked or porous cylinder block
Excessive bearing clearance	Cam bearings, main bearings, rod bearings

High Oil Pressure

Oil too thick	Wrong viscosity, oil full of sludge or tar
Defective oil pressure gauge and/or sender	Verify with an automotive test gauge
Clogged or restricted oil passage	
Oil pump relief valve stuck closed	

Excessive Oil Consumption

Cause	Special Information
Normal consumption.	One quart of oil consumed in 5-15 hours of operation at wide-open-throttle (especially in a new or rebuilt engine) is normal
Oil leaks	Clean bilge, run engine with clean white paper on bilge floor, locate oil leak(s)
Oil too thin	Oil diluted or wrong viscosity
Oil level too high	
Drain holes in cylinder head plugged	Oil will flood valve guides
Defective valve seals	
Intake manifold gasket leaking	
Worn valve stems or valve guides	
Defective oil cooler (if so equipped)	Crack in cooler tubes
Defective piston rings	Glazed, scuffed, worn, stuck, improperly installed; ring grooves worn; improper break-in; wrong end gap
Defective cylinders	Out of round, scored, tapered, glazed; excessive piston to cylinder clearance; cracked piston
Excessive bearing clearance	

Water in Engine

Important Information

IMPORTANT: First determine location of water in engine. This information can be of great help when trying to determine where the water came from and how it got into the engine. The three most common problems are "water on top of pistons, water in crankcase oil, water in crankcase oil and on top of pistons."

The first step, after locating water, is to remove all the water from the engine by removing all spark plugs and pumping cylinders out by cranking engine over. Next change oil and filter. Now, start engine and see if problem can be duplicated. If problem can be duplicated, there more than likely is a mechanical problem. If the problem cannot be duplicated, the problem is either an operator error or a problem that exists only under certain environmental conditions.

If water is contained to cylinder(s) only, it is usually entering through the intake system, exhaust system, or head gasket.

If the water is contained to crankcase only, it is usually caused by a cracked or porous block, a flooded bilge, or condensation.

If the water is located in both the cylinder(s) and the crankcase, it is usually caused by water in the cylinders getting past the rings and valves, or complete submersion.

Checking for rust in the intake manifold or exhaust manifolds is a good idea. Rust in these areas will give clues if the water entered these areas.

Water In Crankcase

Cause	Special Information
Water in boat bilge	Boat has been submerged or bilge water was high enough to run in through dipstick tube
Water seeping past piston rings or valves	Refer to "Water in Engine" ("On Top of Pistons")
Engine running cold	Defective thermostat, missing thermostat; prolonged idling in cold water
Intake manifold leaking near a water passage	
Cracked or porous casting	Check cylinder head, cylinder block, and intake manifold

Water On Top Pistons

Cause	Special Information
Operator shut engine off at high RPM	
Engine “diesels” or tries to run backwards	Engine out of tune, poor fuel, high idle RPM, timing set too high
Rain water running into flame arrestor	Hatch cover
Spark plug misfiring	Improper combustion causes moisture in the air to accumulate in the cylinder
Backwash through the exhaust system	
Improper engine or exhaust hose installation	
Cracked exhaust manifold	
Improper manifold to elbow gasket installation	
Loose cylinder head bolts	
Blown cylinder head gasket	Check for warped cylinder head or cylinder block
Cracked valve seat	
Porous or cracked casting	Check cylinder heads, cylinder block, and intake manifold

Engine Overheats (Mechanical)

Cause	Special Information
Engine RPM below specifications at wide-open-throttle (engine laboring)	Damaged or wrong propeller; growth on boat bottom;false bottom full of water
Wrong ignition timing	Timing too far advanced or retarded
Sticking distributor advance weights	
Spark plug wires crossed (wrong firing order)	
Lean fuel mixture	Refer to “Carburetor Malfunctions” in this section
Wrong heat range spark plugs	
Exhaust restriction	
Valve timing off	Jumped timing chain, or improperly installed
	A blown head gasket(s) normally cannot be detected by a compression check. Normally the engine will run at normal temperature at low RPM, but will overheat at speeds above 3000 RPM.
Blown head gasket(s)	**Engines that are seawater cooled**: Using a clear plastic hose, look for air bubbles between seawater pump and engine. If there are no bubbles present, install clear plastic hose between thermostat housing and manifold(s).If air bubbles are present at a higher RPM, it is a good indication there is a blown head gasket.
Insufficient lubrication to moving parts of engine	Defective oil pump, plugged oil passage, low oil level

Engine Overheats (Cooling System)

Cause	Special Information
IMPORTANT: The first step is to verify if the engine is actually overheating or the temperature gauge or sender is faulty Loose or broken drive belt	**IMPORTANT: Best way to test gauge or sender is to replace them.**
Seawater shutoff valve partially or fully closed (if equipped)	
Clogged or improperly installed sea strainer	
Loose hose connections between seawater pickup and seawater pump inlet (models with belt driven seawater pump only)	Pump will suck air. Pump may fail to prime or will force air bubbles into cooling system.
Seawater inlet hose kinked or collapsed	
Seawater pickup clogged	
Obstruction on boat bottom causing water turbulence	Obstruction will be in front of seawater pickup, causing air bubbles to be forced into cooling system
Defective thermostat	
Exhaust elbow water outlet holes plugged	
Insufficient seawater pump operation	Worn pump impeller
Obstruction in cooling system such as casting flash, sand, rust, salt, etc.	Refer to water flow diagram for engine type being serviced
Engine circulating pump defective	
Also refer to “Engine Overheats (Mechanical)”	
IMPORTANT: In addition to previous checks, make the following checks if engine is equipped with closed cooling.	
Low coolant level	
Antifreeze not mixed properly	Antifreeze should be mixed 50/50 or maximum 60/40 (60% antifreeze, 40% water)
Heat exchanger cores plugged	
Water hoses reversed at the water distribution block	Refer to water flow diagram in Section 6

Insufficient Water Flow From Belt Driven Seawater Pump

Cause	Special Information
Drive belt	Loose, worn or broken
Seawater shutoff valve partially or fully closed	
Clogged or improperly installed sea strainer	
Loose hose connections between seawater pickup and seawater pump inlet	Pump will suck air, pump may fail to prime or will force air bubbles into cooling system
Seawater inlet hose kinked or plugged	
Seawater pickup plugged	
Obstruction on boat bottom causing water turbulence.	Obstruction will be in front of seawater pickup, causing air bubbles to be forced into cooling system
Faulty seawater pump	

Power Steering

Poor, Erratic, or No Assist

Cause	Special Information
Drive belt	Worn, broken or out of adjustment
Low fluid level	
Air in system	Air leak in lines, pump, or air from installation. Refer to Section 9A for bleeding procedure.
Leaking hoses	Refer to Section 10A for bleeding procedure.
Steering cables and/or steering helm	Cable or helm partially frozen from rust or corrosion; cable over-lubricated; improper cable installation.
Binding in stern drive unit	Refer to appropriate Stern Drive Service Manual
Restriction in hydraulic hoses	Causes a loss of pressure
Control valve not positioned properly, not balanced properly, or the mounting nut is loose	
Mounting bracket adjusting screw loose or mounting tube is loose	
Faulty pump	Flow control valve may be sticking
Worn piston ring or scored housing bore in cylinder.	Causes loss of pressure
Leaking valve body or loose fitting spool	

Noisy Pump

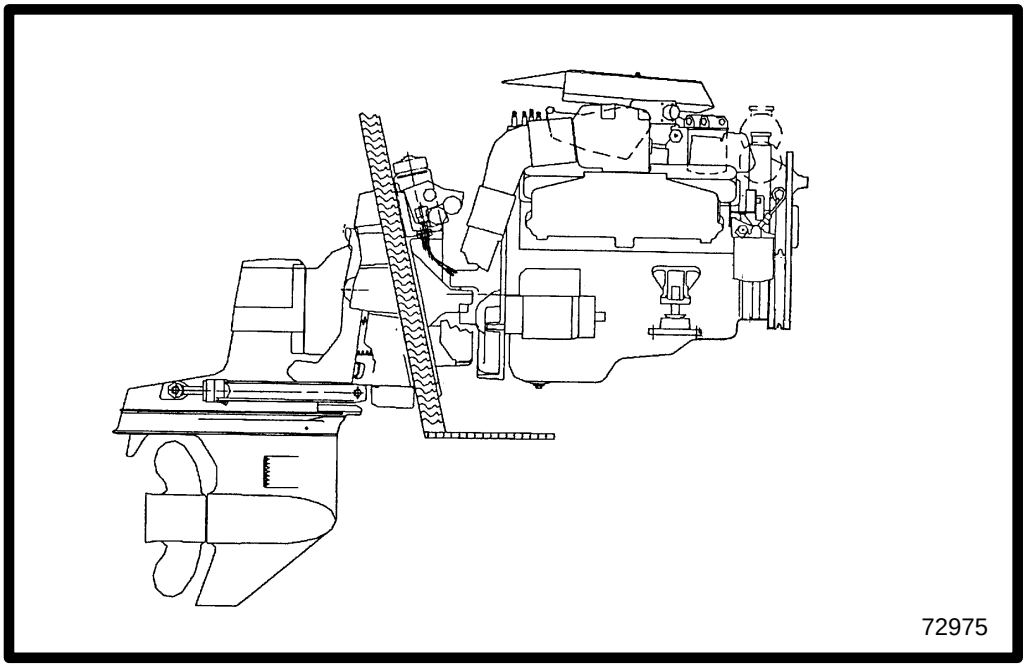
Cause	Special Information
Drive belt	Check belt tension
Low fluid level	
Air in fluid	Air leak in lines, pump, or air form installation
Faulty pump	Use stethoscope to listen for noise in pump
Restricted fluid passages	Kinks or debris in hoses or debris in passages
Stop nut adjusted improperly	Refer to appropriate Stern Drive Service Manual
Steering cables installed that do not meet BIA standards	Refer to appropriate Stern Drive Service Manual

Fluid Leaks

Cause	Special Information
Loose hose connections	Refer to Section 10A for bleeding instructions
Damaged hose	
Oil leaking from top of pump	System overfilled; fluid contains water; fluid contains air
Cylinder piston rod seal	
Faulty seals in valve	
Faulty seals in o-rings in pump	
Cracked or porous metal parts	

REMOVAL AND INSTALLATION

2
A



MCM MODELS - ALPHA ONE DRIVES

Index

Table of Contents

	Page
Torque Specification	2A-1
Tools/Lubricants/Adhesives/Sealants	2A-1
Removal	2A-2
Installation	2A-3

Torque Specification

Fastener Location		Lb. In.	Lb. Ft.	N·m
Drive Unit Shift Cable	Cable Barrel	Spread Cotter Key		
	Cable End Guide	See Note		
Hose Clamps		Securely		
Rear Engine Mounts			35-40	47-54
Power Steering Fluid Hose Fitting				
Earlier Style Large			23	31
Small		100		11
Later Style			23	31
Rear Engine Mounts			35-40	47-54
Remote Control Shift Cables	Cable Barrel	Securely		
	Cable End Guide	See Note		
Remote Control Throttle Cable	Cable Barrel	Securely		
	Cable End Guide	See Note		

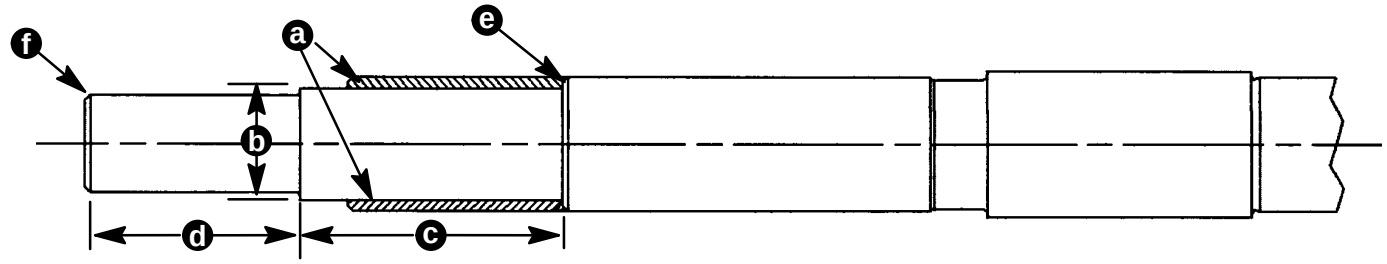
NOTE: *Tighten, then back nut off one half turn*

Tools/Lubricants/Adhesives/Sealants

Part Number	Description
91-805475 A1	Quicksilver Engine Alignment Tool
91-816391 A4	Quicksilver Engine Coupler Spline Grease
92-25711--2	Quicksilver Liquid Neoprene
Obtain Locally	Loctite Pipe Sealant with Teflon

CAUTION ⚠

DO NOT use an alignment tool from another manufacturer. Alignment tools other than Quicksilver Alignment Tools (91-805475A1 or a properly modified 91-57797A3) may cause improper alignment and damage to gimbal bearing and/or engine coupler.



a - Material To Be Removed (Shaded Area)
b - Measurement - 1.150 in. (29.21 mm)
c - Measurement - 2.750 in. (69.85 mm)
d - Measurement - 2.200 in. (55.88 mm)
e - Radius - .060 (1.5 mm)
f - Chamfer - .060 in. (1.5 mm) x 45 degree

Quicksilver Engine Alignment Tool (91-57797A3) Modification

Index

Removal

IMPORTANT: Stern drive unit must be removed prior to engine removal. Refer to Stern Drive Service Manual.

Engine Removal

1. Disconnect battery cables from battery.
2. Remove instrument harness connector plug from engine harness receptacle after loosening clamp.

⚠WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

3. Disconnect and suitably plug fuel line to prevent fuel in tank from leaking into bilge.
4. Disconnect throttle cable from carburetor and retain locknuts and hardware.
5. Disconnect bullet connectors of trim sender wires (coming from transom assembly) from engine harness.

NOTE: *After wires are disconnected be sure to loosen them from clamps or Sta-Straps retaining them to engine or hoses.*

6. Slide sleeves back on BLACK and WHITE/GREEN (or gray) wires and disconnect engine harness wires from shift cut-out switch harness.
7. Disconnect MerCathode wires from MerCathode controller if so equipped.
8. Disconnect seawater inlet hose from gimbal housing.
9. Disconnect exhaust elbow hoses (bellows).
10. Remove both shift cables from shift plate. Retain locknuts and hardware.
11. Disconnect any grounding wires and accessories that are connected to engine.
12. Disconnect (and suitably plug) fluid hoses from power steering control valve on transom.

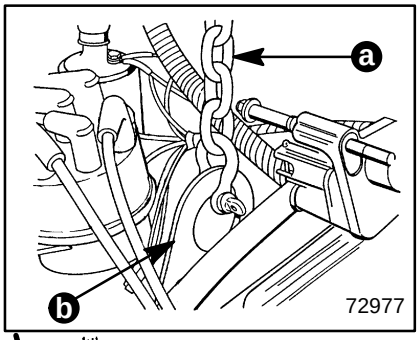
⚠CAUTION

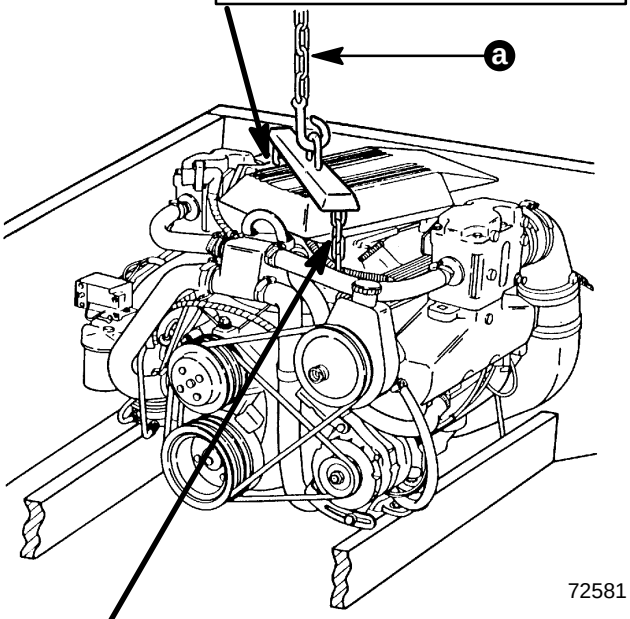
Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

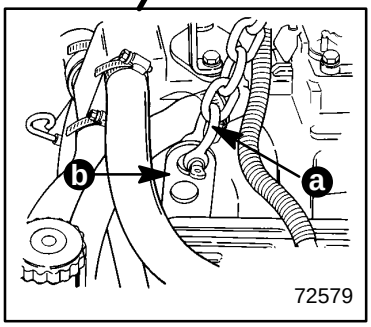
⚠CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage will occur.

13. Support engine with suitable sling through lifting eyes on engine and remove front and rear engine mounting bolts. Retain hardware.







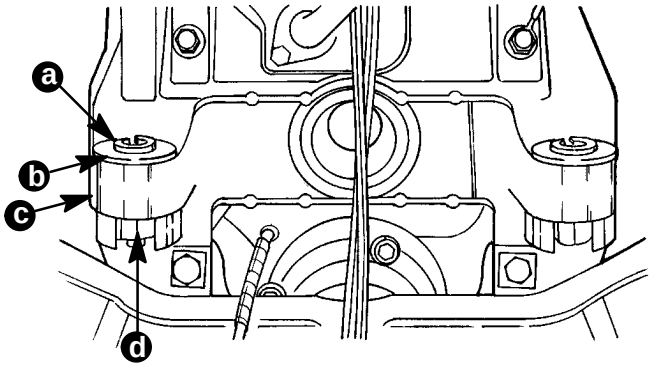
a - Suitable Sling
b - Engine Lifting Eyes

14. Carefully remove engine. DO NOT hit power steering control valve.

Installation

Engine Installation/Alignment

1. Follow instructions “a”-“e”:
   a. Be certain fiber washers (cemented in place) on inner transom plate are present. Inspect fiber washers. Replace if worn or damaged.
   b. Install double wound lockwashers onto inner transom plate inside fiber washer.
   c. Be certain rear engine mount locknuts are in position as shown.
   d. Lubricate exhaust bellows with soap and water to ease installation.
   e. Lubricate engine coupling splines with Quicksilver Engine Coupler Spline Grease.



72023

c - Double Wound Lockwasher
d - Fiber Washer (Cemented in Place)
e - Inner Transom Plate Mount (Engine Support)
f - Locknuts (Engine Mounting Bolts)

⚠CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

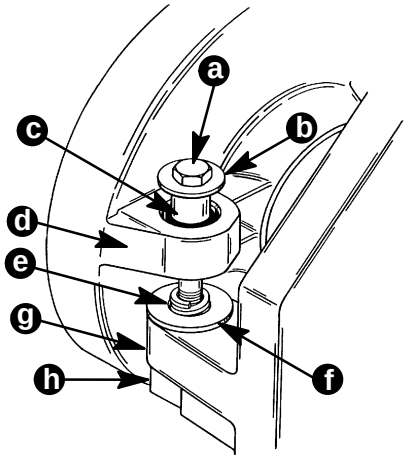
⚠CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage will occur.

2. Attach a suitable sling to lifting eyes on engine and adjust so that engine is level when suspended. **(Refer to “Removal” section for location of lifting eyes.)**
3. Lift engine into position (in boat), using an overhead hoist.
4. Align rear engine mounts with inner transom plate mounts while simultaneously aligning exhaust tubes with exhaust pipe hoses (bellows).

IMPORTANT: Engine attaching hardware must be installed in sequence shown.

5. Install both rear engine mounting bolts and hardware as shown. Torque to 35-40 lb. ft. (47-54 N·m).



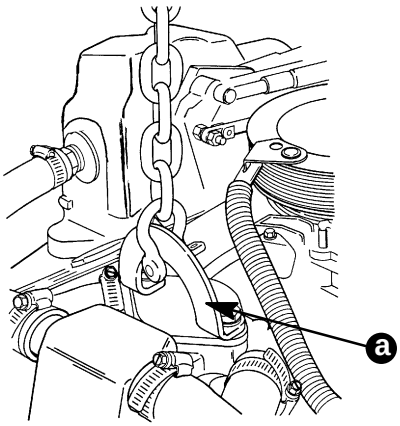
72535

a - Bolt, Rear Engine Mounting
b - Washer, Large Steel
c - Spacer, Metal
d - Rear Engine Mount
e - Double Wound Lockwasher
f - Fiber Washer (Cemented in Place)
g - Inner Transom Plate Mounts
h - Locknuts (Hidden In This View)

⚠CAUTION

When lowering engine into position DO NOT set engine on shift cable. Shift cable outer casing can be crushed causing difficult or improper shifting.

6. Set engine down on stringers and relieve hoist tension. Disconnect sling from engine lifting eyes and switch sling to center lifting eye.



72024

a - Center Lifting Eye

Index

⚠CAUTION

DO NOT use an alignment tool from another manufacturer. Alignment tools other than Quicksilver Alignment Tool 91-805475A1, may cause improper alignment and damage to gimbal bearing and/or engine coupler.

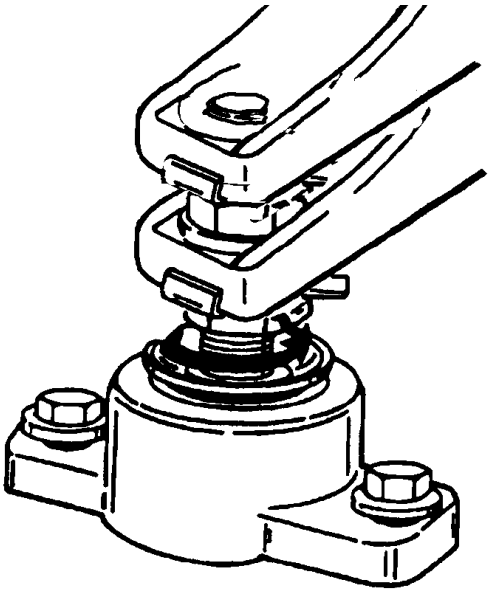
⚠CAUTION

To avoid damage to gimbal bearing, engine coupler, or alignment tool:

- **DO NOT attempt to force alignment tool!**
- **DO NOT raise or lower engine with alignment tool inserted (or partially inserted) in gimbal bearing or engine coupler.**

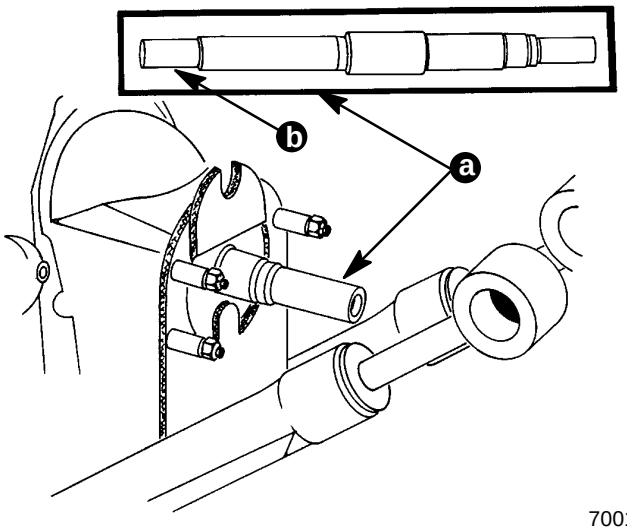
⚠CAUTION

Avoid damage to exhaust system. Engines with single piece manifolds, stress can be placed on the lower exhaust pipe if front of engine is raised too high while performing engine alignment procedure. Ensure that engine is not raised higher than the top of engine mount adjusting stud.



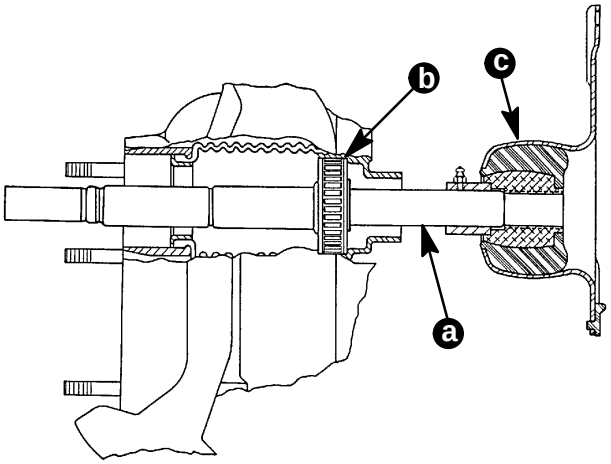
75129

7. Align engine as follows:
   a. Attempt to insert solid end of Quicksilver Alignment Tool through gimbal bearing and into engine coupler splines. If it will not insert easily proceed to following.
   b. While observing the above precautions, CAREFULLY raise and lower front of engine with hoist, as required, until tool will SLIDE FREELY all the way in and out of engine coupler splines.



70013

a - Alignment Tool (Use Only Quicksilver Alignment Tool 91-805475A1, or Properly Modified 91-57797A3)
b - Insert This End of Alignment Tool through Gimbal Housing Assembly



72585

a - Alignment
b - Gimbal Bearing
c - Engine Coupler

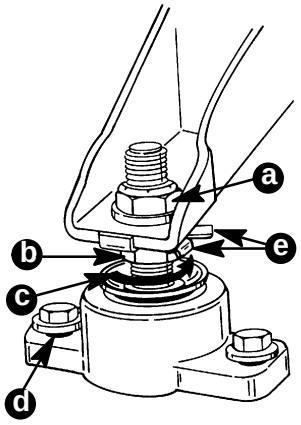
IMPORTANT: Turn both front engine mount adjustment nuts an equal amount in direction required to align engine.

   c. Adjust front engine mounts until they rest on boat stringers.
   d. Relieve hoist tension entirely and fasten both front mounts to boat stringer using appropriate hardware (lag bolts or thru-bolts, etc).

e. Recheck alignment with alignment tool. Tool must enter coupler splines freely. If not, readjust front mounts.

f. When alignment is correct, tighten locknut or nut with lockwasher on each mount securely.

g. Bend tab washer down against flat on adjusting nut.

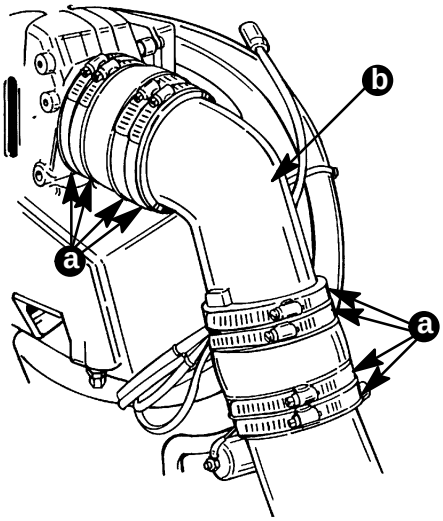


72536

a - Nut and Lockwasher
b - Adjustment Nut
c - Turn Adjustment Nut in This Direction (Counterclockwise)
d - Slotted Hole Toward Front of Engine
e - Tab Washer

h. Remove alignment tool if not already removed.

8. Tighten all exhaust system hose clamps securely as follows (use two hose clamps on each connection):



72537

Typical

a - Hose Clamps - Tighten Securely
b - Exhaust Tube - Long Tube - Port Side; Short Tube - Starboard Side

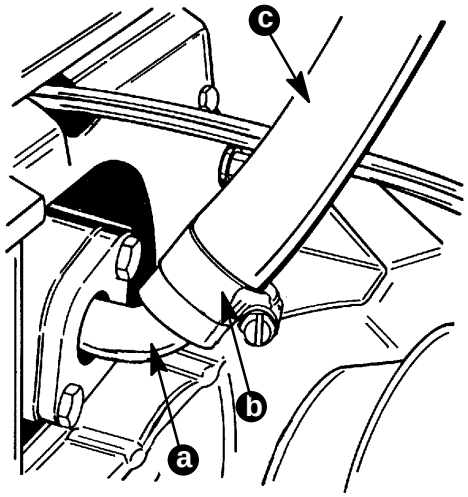
9. Proceed to “Engine Connections” section instructions following.

Engine Connections

IMPORTANT: When routing all wire harnesses and hoses, be sure they are routed and secured to avoid coming in contact with hot spots on engine and avoid contact with moving parts.

1. Connect seawater hose to water tube at gimbal housing with hose clamp. Tighten clamp securely.

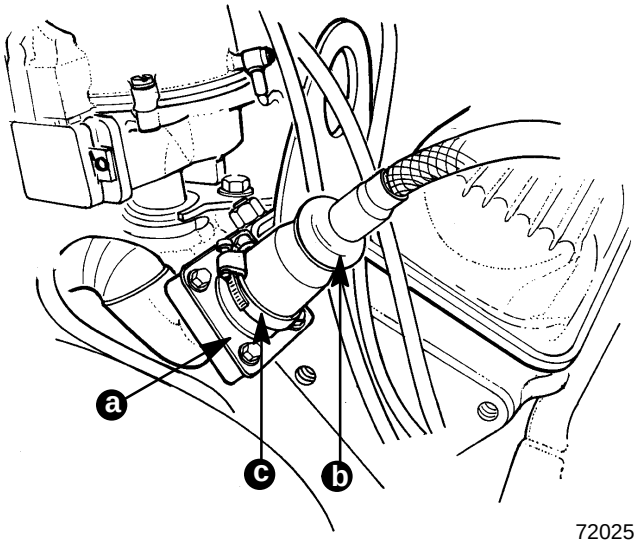
NOTE: *In the following view the engine is not in position, for visual clarity in this step.*



72614

a - Water Inlet Tube
b - Hose Clamp
c - Seawater Inlet

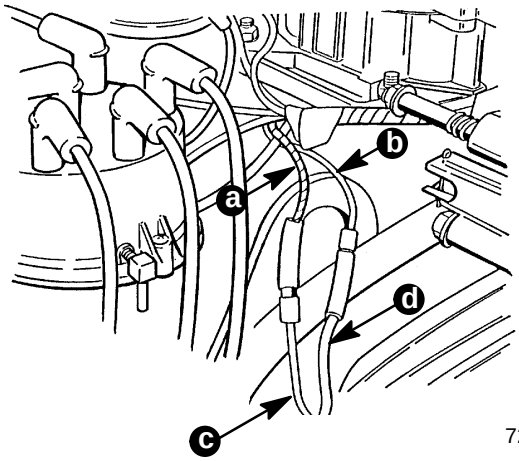
2. Connect instrument harness to engine harness with hose clamp. Tighten clamp securely.



72025

a - Engine Wiring Harness Receptacle Bracket
b - Instrumentation Wiring Harness Plug
c - Hose Clamp

3. Connect trim position sender leads from gimbal housing to leads from engine harness.



72992

a - BROWN/WHITE (From Engine Harness)
b - BLACK (From Engine Harness)
c - BLACK (From Transom Assembly)
d - BLACK (From Transom Assembly)

⚠WARNING

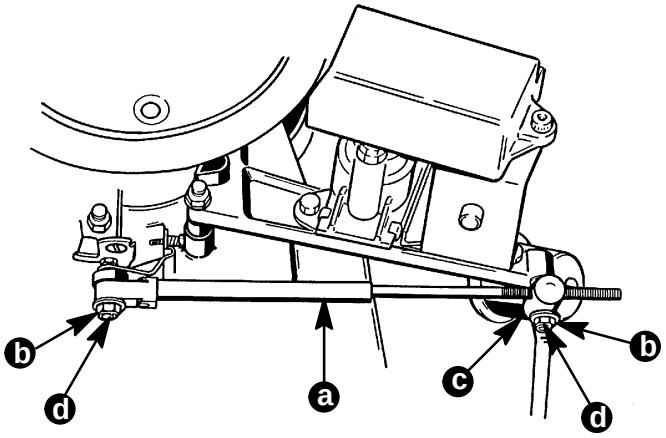
Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

4. Connect fuel line from fuel tank(s) to engine. Make certain connections are secure. Check for leaks.
5. Connect throttle cable using hardware retained and adjust as follows:
   a. Place remote control handle(s) in neutral, idle position.

IMPORTANT: Be sure that cable is routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable. Outer cable must be free to move when cable is actuated.

   b. Install cable end guide on throttle lever, then push cable barrel lightly toward throttle lever end. (This will place a slight preload on cable to avoid slack in cable when moving remote control lever.) Adjust barrel on throttle cable to align with anchor stud.
   c. Secure throttle cable with hardware (retained) as shown. Tighten cable end guide locknut until it bottoms out and then back off one full turn. Tighten cable barrel securely. DO NOT OVER-TIGHTEN, as cable must pivot freely.

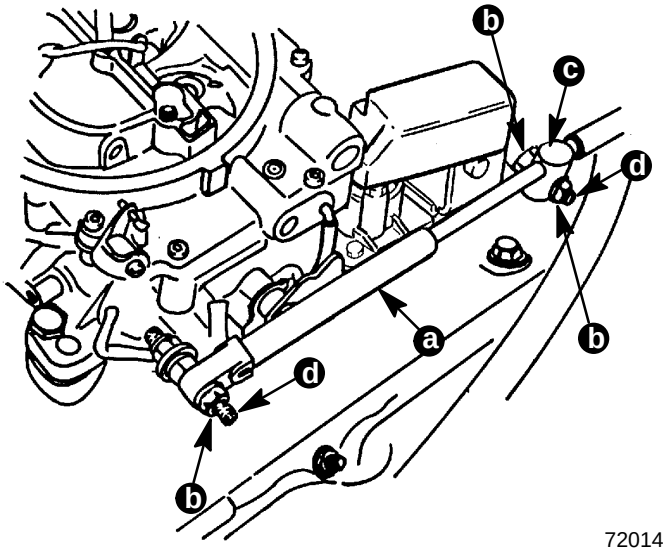
2 BARREL CARBURETOR



72013

a - Cable End Guide
b - Attaching Hardware
c - Cable Barrel
d - Anchor Studs

4 BARREL CARBURETOR

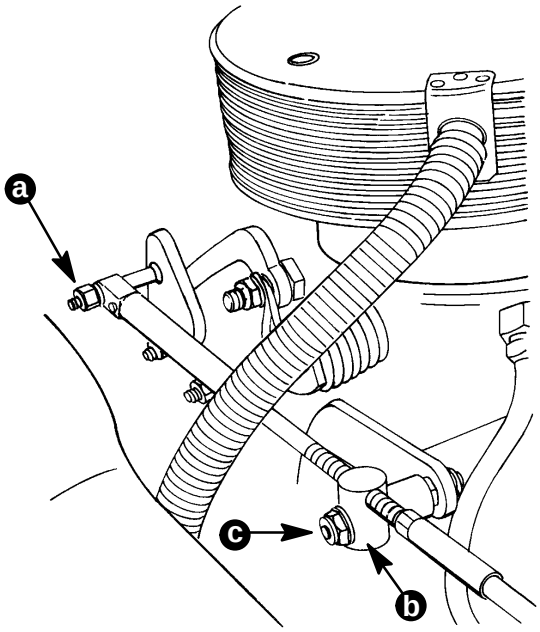


72014

a - Cable End Guide
b - Attaching Hardware
c - Cable Barrel
d - Anchor Studs

d. Place remote control throttle lever in the wide-open-throttle (W.O.T.) position. Check to ensure that throttle shutters (valves) are completely open and throttle shaft lever contacts carburetor body casting.

THROTTLE BODY FUEL INJECTION

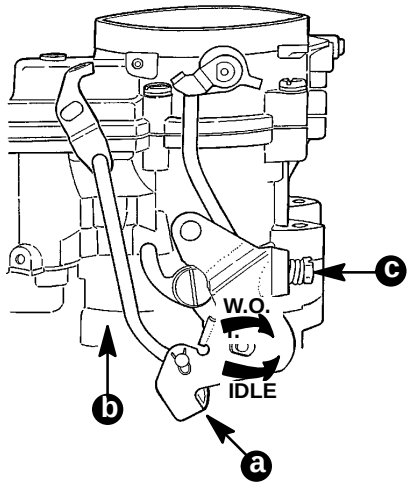


71711

a - Flat Washer and Locknut - Tighten Until Nut Bottoms Out, Then Back Off 1/2 Turn.
b - Cable Barrel
c - Flat Washer And Locknut

e. Return remote control throttle lever to idle position and check to ensure that throttle lever contacts idle speed adjustment screw.

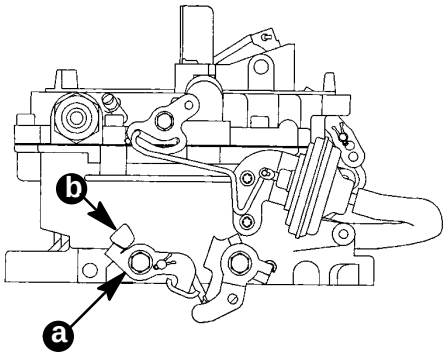
MERCARB 2 BARREL CARBURETOR



72283

a - Throttle Lever Tang
b - Carburetor Body
c - Idle RPM Adjustment Screw

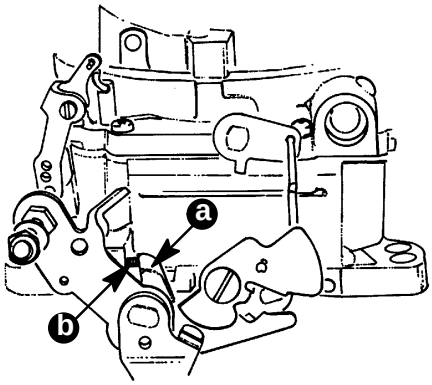
WEBER 4 BARREL CARBURETOR



71159

Wide Open Throttle Position

a - Throttle Shaft Lever [Contacts (b) at W.O.T. Position]
b - Carburetor Body Casting



70392

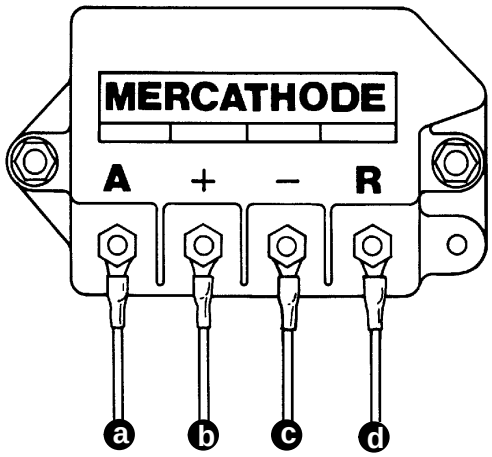
Idle Position

a - Throttle Shaft Lever [Contacts (b) at W.O.T. Position]
b - Idle Speed Adjustment Screw

IMPORTANT: Do not attach any accessory ground (–) wires to transom plate ground point. Accessory ground wires should only be attached to ground stud on engine.

6. Connect any grounding wires or accessories that may have been disconnected.

7. Connect MerCathode wires to MerCathode controller assembly as shown, if so equipped. Apply a thin coat of Quicksilver Liquid Neoprene to all connections.



22232

a - ORANGE Wire - From Electrode on Transom Assembly
b - RED/PURPLE Wire - Connect (Other End) to Positive (+) Battery Terminal
c - BLACK WIRE - From Engine Harness
d - BROWN WIRE - From Electrode on Transom Assembly

IMPORTANT: Adjust shift cables as outlined in appropriate Stern Drive Service Manual.

8. Refer to appropriate Stern Drive Service Manual and install and adjust drive unit and remote control shift cables, using hardware retained.

IMPORTANT: After fluid hose installation in the following, bleed power steering system as outlined in SECTION 1B - "Maintenance" or refer to appropriate Stern Drive Service Manual.

9. Connect power steering fluid hoses to control valve (large fitting first) as shown.

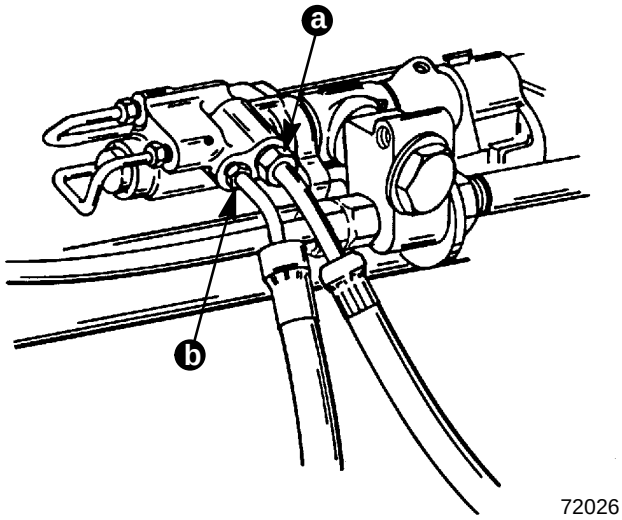
⚠ CAUTION

Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hose.

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leakage.

IMPORTANT: Be careful not to cross-thread or over tighten fittings.

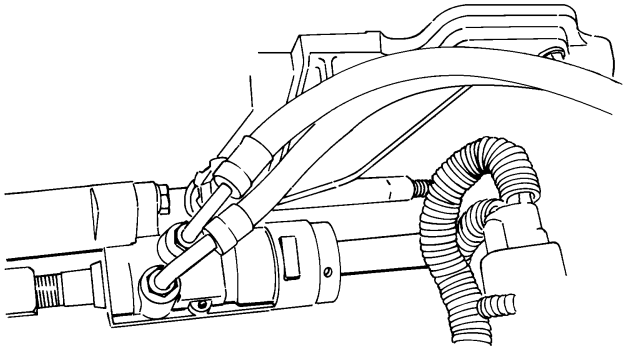
Earlier Style Control Valve: Torque large fitting to 20-25 lb. ft. (27-34 N·m) and small fitting to 96-108 lb. in. (11-12 N·m).



72026

a - Large Fitting
b - Small Fitting

Later Style Control Valve: Torque fittings to 23 lb. ft. (31 N·m)



73786

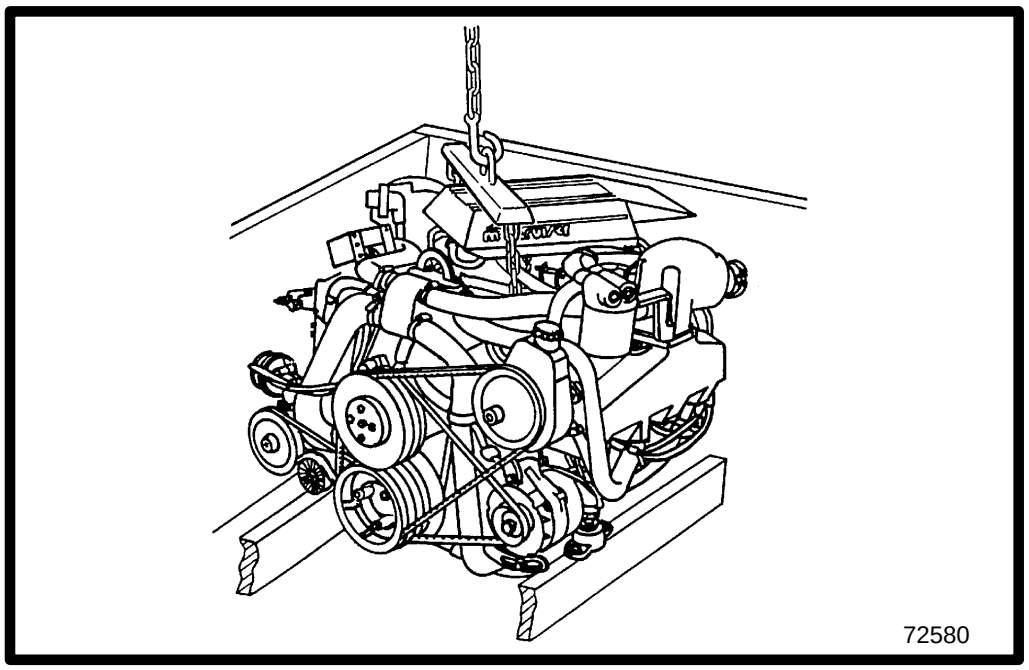
10. Connect battery cables to battery by FIRST connecting POSITIVE (+) battery cable (usually red) to POSITIVE (+) battery terminal. Tighten clamp securely. Then, connect NEGATIVE (–) battery cable (usually black) to NEGATIVE (–) battery terminal. Tighten clamp securely.

NOTE: *Spray terminals with a battery connection sealant to help retard corrosion.*

REMOVAL AND INSTALLATION

2

B



MCM MODELS - BRAVO DRIVES

Index

Table of Contents

	Page
Torque Specifications	2B-1
Tools/Lubricants/Adhesives/Sealants	2B-1
Removal	2B-2
Engine Removal	2B-2
Installation	2B-3
Engine Installation/Alignment	2B-3
Engine Connections	2B-6
Throttle Connections	2B-7

Index

Torque Specifications

Fastener Location		Lb. In.	Lb. Ft.	N·m
Drive Unit Shift Cable	Cable Barrel	Spread Cotter Key		
	Cable End Guide	See Note		
Hose Clamps		Securely		
Rear Engine Mounts			35-40	47-54
Power Steering Fluid Hose Fitting				
Earlier Style Large			23	31
Small		100		11
Later Style			23	31
Rear Engine Mounts			35-40	47-54
Remote Control Shift Cables	Cable Barrel	Securely		
	Cable End Guide	See Note		
Remote Control Throttle Cable	Cable Barrel	Securely		
	Cable End Guide	See Note		

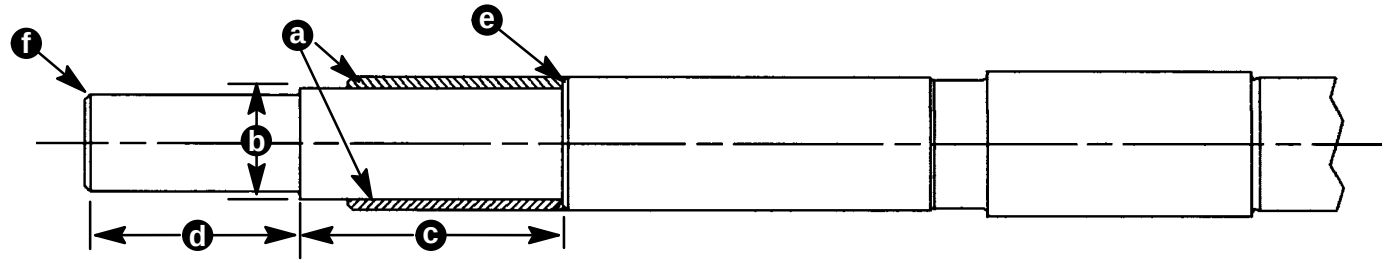
Note: Tighten, then back nut off one half turn.

Tools/Lubricants/Adhesives/Sealants

DESCRIPTION	PART NUMBER
Engine Alignment Tool	91-805475A1
Engine Coupler Spline Grease	91-816391A4
Liquid Neoprene	92-27511-2
Loctite Pipe Sealant With Teflon	Obtain Locally

CAUTION

DO NOT use an alignment tool from another manufacturer. Alignment tools other than Quicksilver Alignment Tools (91-805475A1 or a properly modified 91-57797A3) may cause improper alignment and damage to gimbal bearing and/or engine coupler.



a - Material To Be Removed (Shaded Area)
b - Measurement - 1.150 in. (29.21 mm)
c - Measurement - 2.750 in. (69.85 mm)
d - Measurement - 2.200 in. (55.88 mm)
e - Radius - .060 (1.5 mm)
f - Chamfer - .060 in. (1.5 mm) x 45 degree

Quicksilver Engine Alignment Tool (91-57797A3) Modification

Removal

IMPORTANT: Stern drive unit must be removed prior to engine removal. Refer to Stern Drive Service Manual.

Engine Removal

1. Disconnect battery cables from battery.
2. Remove instrument harness connector plug from engine harness receptacle after loosening clamp.

⚠ WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

3. Using wrench to stabilize brass filter nut at fuel inlet, loosen fuel line fitting, disconnect and suitably plug fuel line to prevent fuel in tank from leaking into bilge.
4. Disconnect throttle cable from carburetor, or throttle body on Fuel Injection models, and retain locknuts and hardware.
5. Disconnect bullet connectors of trim sender wires (coming from transom assembly) from engine harness.

NOTE: *After wires are disconnected be sure to loosen them from clamps or sta-straps retaining them to engine or hoses.*

6. Disconnect MerCathode wires from MerCathode controller if mounted on engine (some models).
7. Disconnect seawater inlet hose from gimbal housing.
8. Disconnect exhaust elbow hoses (bellows).
9. Remove both shift cables from shift plate. Retain locknuts and hardware.
10. Disconnect any grounding wires and accessories that are connected to engine.
11. Disconnect (and suitably plug) fluid hoses from power steering control valve on transom.

⚠ CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

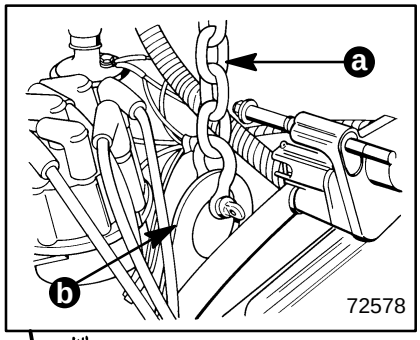
⚠ CAUTION

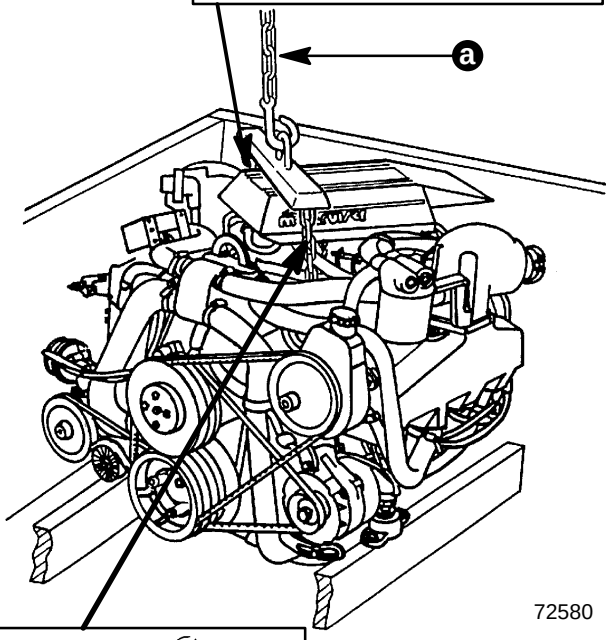
DO NOT allow lifting sling to hook or compress engine components or damage will occur.

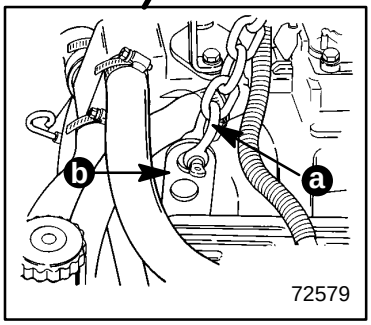
⚠ CAUTION

Multi-Port engines MUST be lifted with a lifting arm or damage to engine components will occur.

12. Support engine with suitable sling through lifting eyes on engine and remove front and rear engine mounting bolts. Retain hardware.







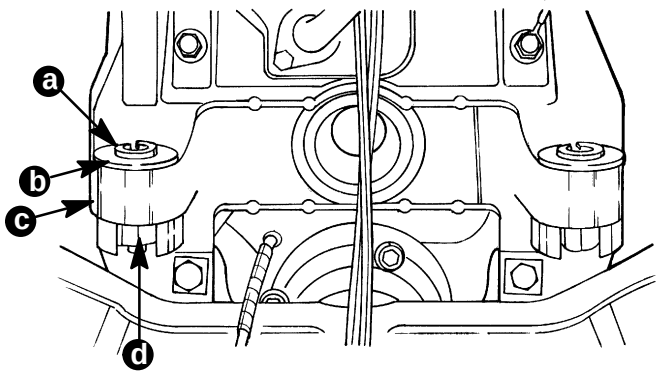
a - Suitable Sling
b - Engine Lifting Eyes

13. Carefully remove engine. DO NOT hit power steering control valve.

Installation

Engine Installation/Alignment

1. Follow instructions “a”- “e”:
   a. Be certain fiber washers (cemented in place) on inner transom plate are present. Inspect fiber washers. Replace if worn or damaged.
   b. Install double wound lockwashers onto inner transom plate inside fiber washer.
   c. Be certain rear engine mount locknuts are in position as shown.
   d. Lubricate exhaust bellows with soap and water to ease installation.
   e. Lubricate engine coupler splines with Quicksilver Engine Coupler Spline Grease.



72023

a - Double Wound Lockwasher
b - Fiber Wound Lockwasher (Cemented In Place)
c - Inner Transom Plate Mount (Engine Support)
d - Locknuts (Engine Mounting Bolts)

⚠CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

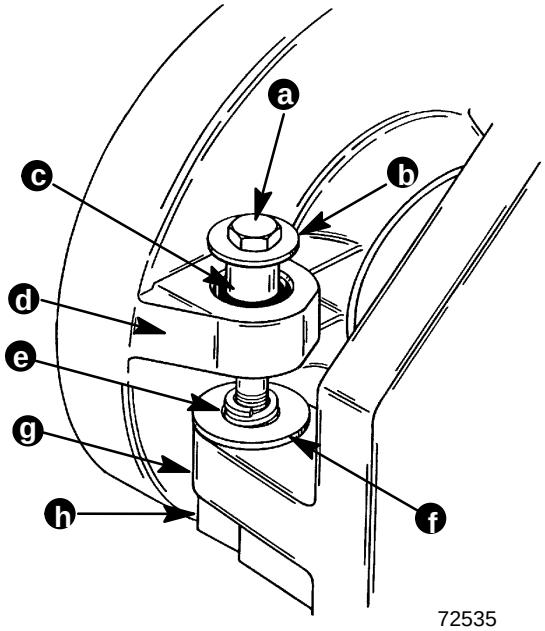
⚠CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage will occur.

2. Attach a suitable sling to lifting eyes on engine and adjust so that engine is level when suspended. **(Refer to “Removal” section for location of lifting eyes.)**
3. Lift engine into position (in boat), using an overhead hoist.
4. Align rear engine mounts with inner transom plate mounts while simultaneously aligning exhaust tubes with exhaust pipe hoses (bellows).

IMPORTANT: Engine attaching hardware must be installed in sequence shown.

5. Install both rear engine mounting bolts and hardware as shown. Torque to 35-40 lb. ft. (47-54 N·m).



72535

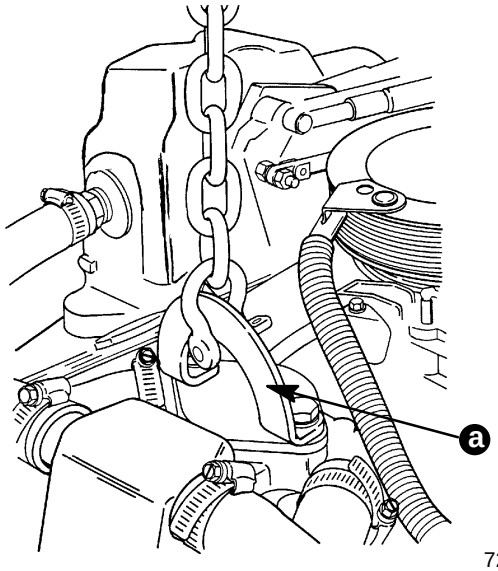
a - Bolt, Rear Engine Mounting
b - Washer, Large Steel
c - Metal Spacer
d - Rear Engine Mount
e - Double Wound Lockwasher
f - Fiber Washer
g - Inner Transom Plate Mounts
h - Locknut (Hidden In This View)

⚠CAUTION

When lowering engine into position DO NOT set engine on shift cable. Shift cable outer casing can be crushed causing difficult or improper shifting.

Index

6. Set engine down on stringers and relieve hoist tension. Disconnect sling from engine lifting eyes and switch sling to center lifting eye.



72024

a - Center Lifting Eye

⚠CAUTION

DO NOT use an alignment tool from another manufacturer. Alignment tools other than Quicksilver Alignment Tool 91-805475A1, may cause improper alignment and damage to gimbal bearing and/or engine coupler.

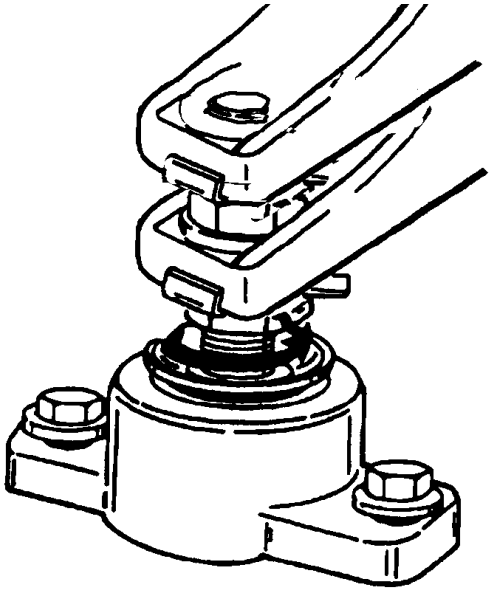
⚠CAUTION

To avoid damage to gimbal bearing, engine coupler, or alignment tool:

- **DO NOT attempt to force alignment tool!**
- **DO NOT raise or lower engine with alignment tool inserted (or partially inserted) in gimbal bearing or engine coupler.**

⚠CAUTION

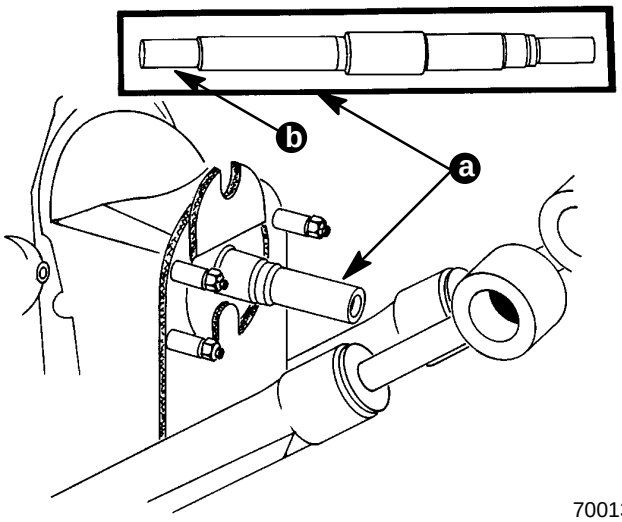
Avoid damage to exhaust system. Engines with single peice manifolds, stress can be placed on the lower exhaust pipe if front of engine is raised too high while performing engine alignment procedure. Ensure that engine is not raised higher than the top of engine mount adjusting stud.



75129

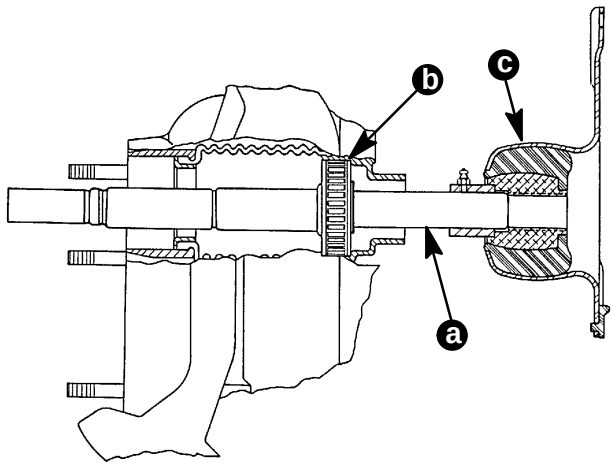
7. Align engine as follows:
   a. Attempt to insert solid end of Quicksilver Alignment Tool through gimbal bearing and into engine coupler splines. If it will not insert easily proceed to following.
   b. If the tool does not fit, remove it and carefully raise or lower the from end of the engine, as necessary, and attempt to insert the alignment tool.

c. Repeat step “b” until the alignment tool installs easily **(SLIDES FREELY)** all the way into and out of engine coupler splines.



70013

a - Alignment Tool (Use Only Quicksilver Alignment Tool (91-805475A1)
b - Insert This End of Alignment Tool through Gimbal Housing Assembly



72585

a - Alignment Tool
b - Gimbal Bearing
c - Engine Coupler

IMPORTANT: Turn both front engine mount adjustment nuts an equal amount in direction required to align engine.

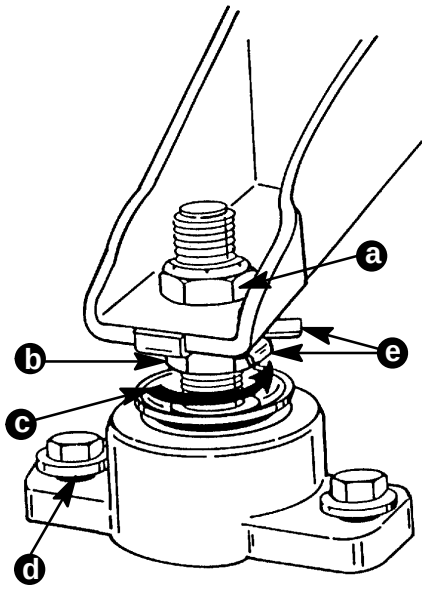
d. Adjust front engine mounts until they rest on boat stringers.

e. Relieve hoist tension entirely and fasten both front mounts to boat stringer using appropriate hardware (lag bolts or thru-bolts, etc.).

f. Recheck alignment with alignment tool. Tool must enter coupler splines freely. If not, readjust front mounts.

g. When alignment is correct, tighten locknut or nut with lockwasher on each mount securely.

h. Bend tab washer down against flat on adjusting nut.



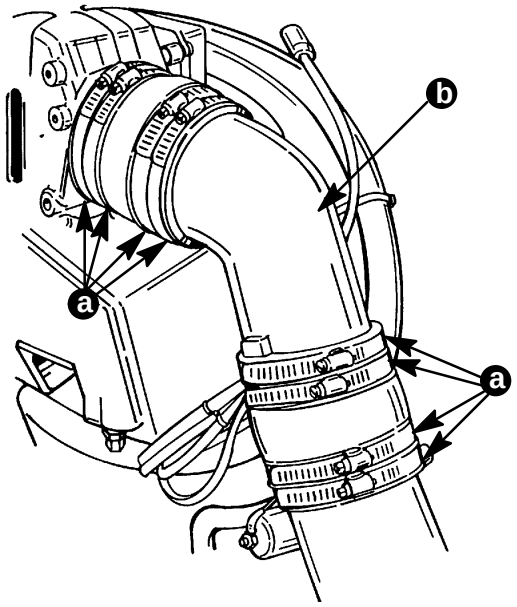
72922

a - Locknut
b - Adjustment Nut
c - Turn Adjustment Nut In This Direction (Counterclockwise) To Raise Front Of Engine
d - Slotted Hole To Front Of Engine
e - Tab Washer

i. Remove alignment tool if not already removed.

8. Tighten all exhaust system hose clamps securely as follows (use two hose clamps on each connection):

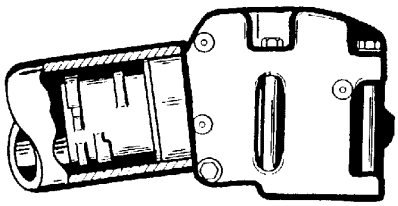
a. **On Engines with Thru-Prop Exhaust:**



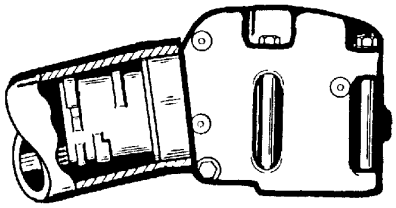
72537

a - Hose Clamps - Tighten Securely
b - Exhaust Tube - Long Tube, Port Side - Short Tube, Star board Side

CORRECT



INCORRECT



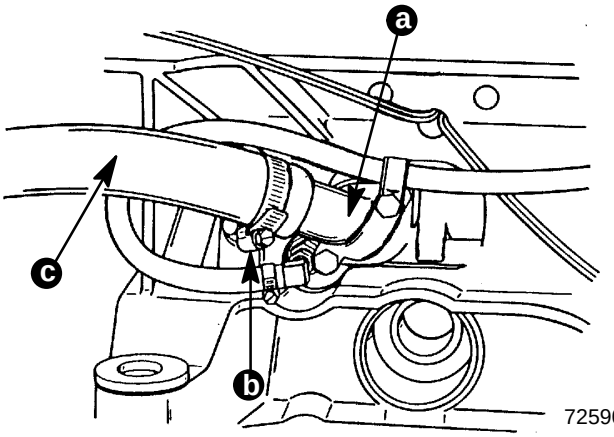
72538

Engine Connections

IMPORTANT: When routing all wire harnesses and hoses, be sure they are routed and secured to avoid coming in contact with hot spots on engine and avoid contact with moving parts.

1. Connect seawater hose to water tube at gimbal housing with hose clamp. Tighten clamp securely.

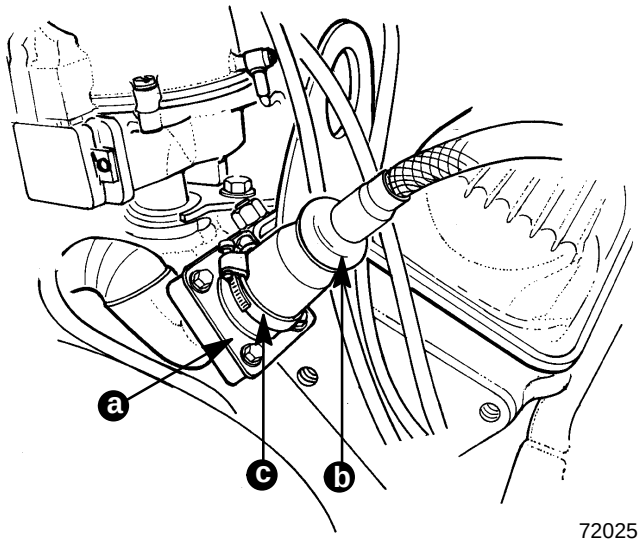
NOTE: *In the following view the engine is not in position, for visual clarity in this step.*



72590

a - Water Inlet Tube
b - Hose Clamp (Tighten Securely)
c - Seawater Inlet

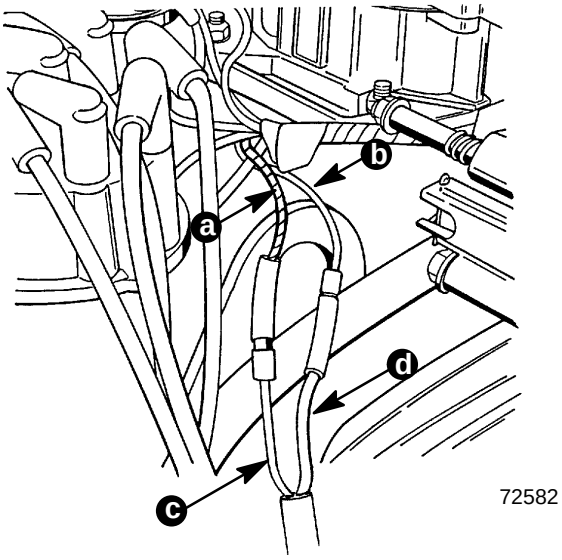
2. Connect instrument harness to engine harness with hose clamp. Tighten clamp securely.



72025

a - Engine Wiring Harness Receptacle Bracket
b - Instrumentation Wiring Harness Plug
c - Hose Clamp - Tighten Securely

3. Connect trim position sender leads from gimbal housing to leads from engine harness.



72582

a - BROWN/WHITE (From Engine Harness)
b - BLACK (From Engine Harness)
c - BLACK (From Transom)
d - BLACK (From Transom Assembly)

⚠ WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

FUEL SUPPLY CONNECTIONS

⚠ WARNING

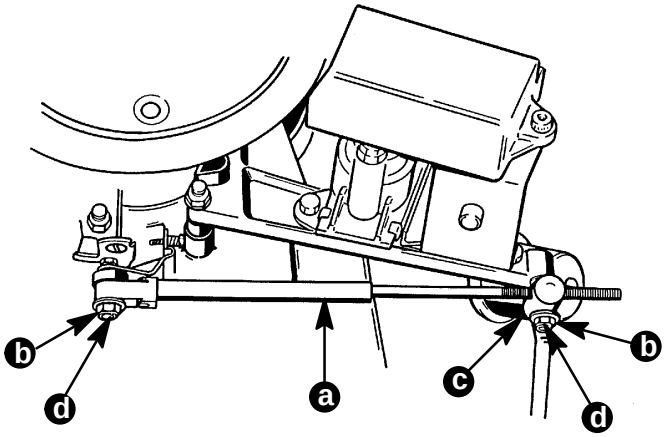
Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

4. Connect fuel line from fuel tank(s) to engine. Make certain connections are secure. Check for leaks.
5. Connect throttle cable using hardware retained and adjust following instructions “a” or “b”:

Throttle Connections

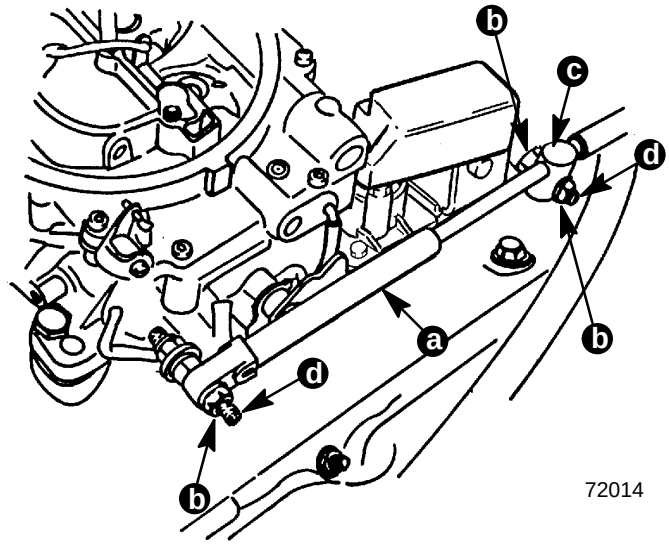
2 BARREL CARBURETOR



72013

a - Cable End Guide
b - Attaching Hardware
c - Cable Barrel
d - Anchor Studs

WEBER 4 BARREL CARBURETOR



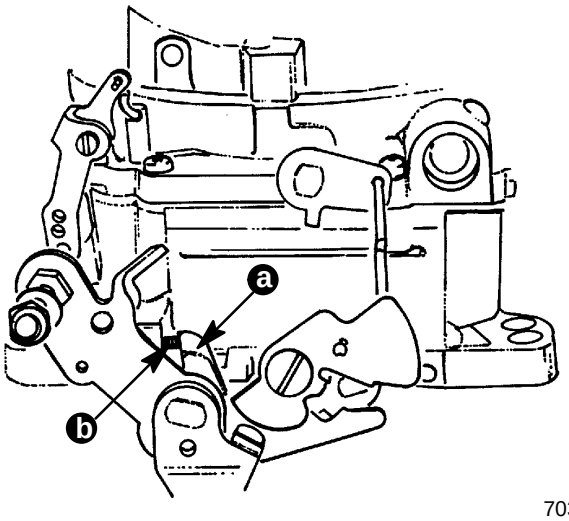
72014

a - Cable End Guide
b - Attaching Hardware (DO NOT Over-Tighten)
c - Cable Barrel
d - Anchor Studs

1. Place remote control handle(s) in neutral, idle position.

IMPORTANT: Be sure that cable is routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable. Outer cable must be free to move when cable is actuated.

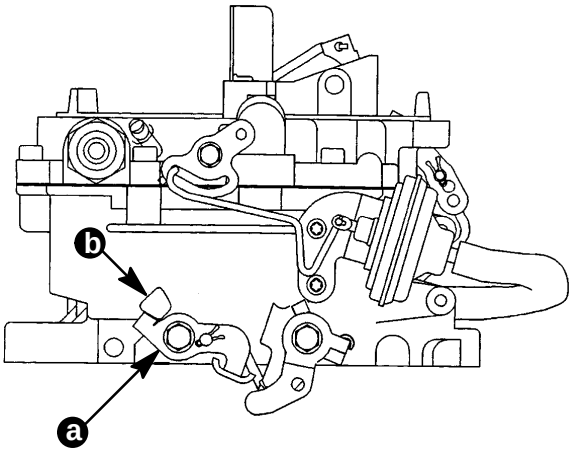
2. Install cable end guide on throttle lever, then push cable barrel lightly toward throttle lever end. (This will place a slight preload on cable to avoid slack in cable when moving remote control lever.) Adjust barrel on throttle cable to align with anchor stud.
3. Secure throttle cable with hardware (retained) as shown. Tighten cable end guide nut until it bottoms out and then back off one full turn. Tighten cable barrel securely. DO NOT OVER-TIGHTEN, as cable must pivot freely.
4. Place remote control throttle lever in the wide-open-throttle (W.O.T.) position. Check to ensure that throttle shutters (valves) are completely open and throttle shaft lever contacts carburetor body casting.
5. Return remote control throttle lever to idle position and check to ensure that throttle lever contacts idle speed adjustment screw.



70392

Idle Position

a - Throttle Lever Contacts (b) In idle Position
b - Idle Speed Adjustment Screw



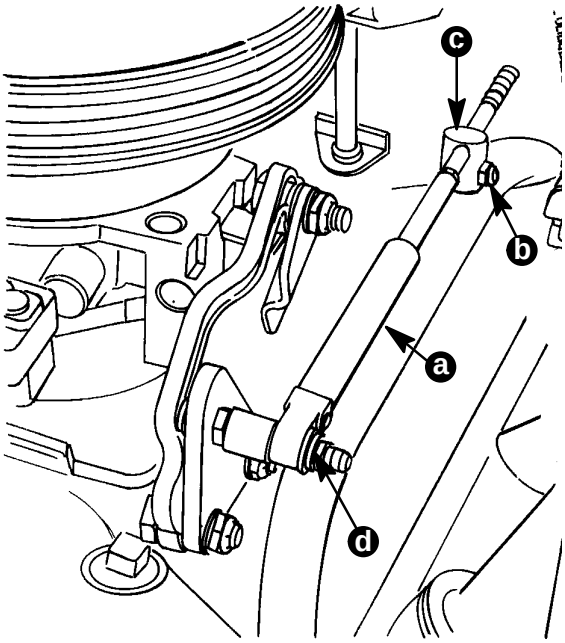
71159

Wide-Open-Throttle Position

a - Throttle Shaft Lever Contacts (b) At W.O.T. Position
b - Carburetor Body Casting

THROTTLE BODY INJECTION

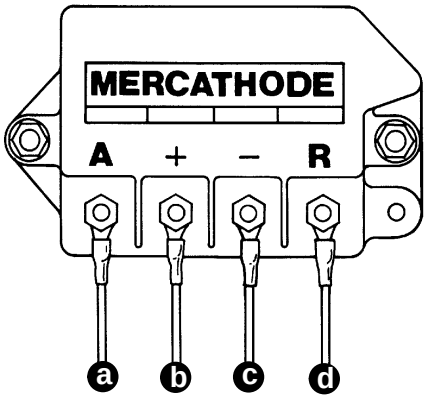
1. Install cable end guide on throttle lever, then push cable barrel end lightly toward throttle lever end. (This will place a slight preload on shift cable to avoid slack in cable when moving remote control lever). Adjust barrel on throttle cable to align with hole in anchor plate.
2. Secure throttle cable with hardware as shown and tighten securely.
3. Place remote control throttle level in the wide open throttle (W.O.T.) position. Check to ensure that throttle plates are completely open.
4. Return remote control throttle lever to idle position.



a - Cable End Guide
b - Flat Washer and Locknut - Tighten Until Bottoms Out, Then Back Off One Half Turn
c - Cable Barrel
d - Flat Washer and Locknut

IMPORTANT: Do not attach any accessory ground (–) wires to transom plate ground point. Accessory ground wires should only be attached to ground stud on engine.

5. Connect any grounding wires or accessories that may have been disconnected.
6. **Models with MerCathode:** Connect wires to MerCathode controller assembly as shown. Apply a thin coat of Quicksilver Liquid Neoprene to all connections.



22232

a - ORANGE Wire - From Electrode On Transom Assembly
b - RED/PURPLE Wire - Connect (Other End) to Positive (+) Battery Terminal
c - BLACK Wire - From Engine Harness
d - BROWN Wire - From Electrode on Transom Assembly

IMPORTANT: Adjust shift cables as outlined in appropriate Stern Drive Service Manual.

7. Refer to appropriate Stern Drive Service Manual and install and adjust drive unit and remote control shift cables, using hardware retained.

IMPORTANT: After fluid hose installation in the following, bleed power steering system as outlined in SECTION 1B - "Maintenance" of this manual, or refer to the appropriate Stern Drive Service Manual.

⚠CAUTION

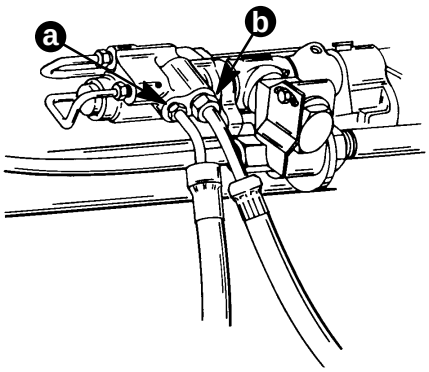
Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hose.

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leakage.

IMPORTANT: Be careful not to cross-thread or over- tighten fittings.

8. Connect both hydraulic hose fittings.

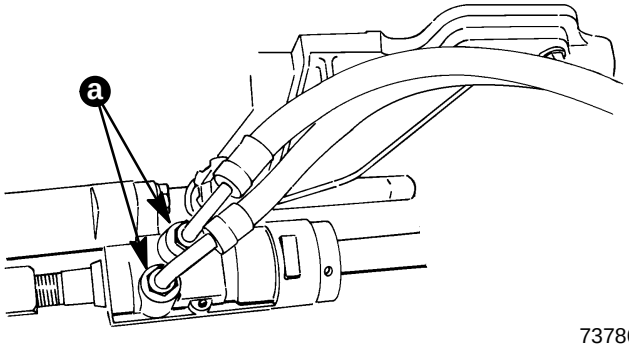
   a. **Earlier Style Control Valves:** Torque the large fitting to 23 lb. ft. (31 N·m). Torque the small fitting to 100 lb. in. (11 N·m).



22023

a - Small Fitting
b - Large Fitting

   b. **Later Style Control Valve:** Torque both fittings to 23 lb. ft. (31 N·m). Route hoses as shown for each model



73786

a - Hose Fittings

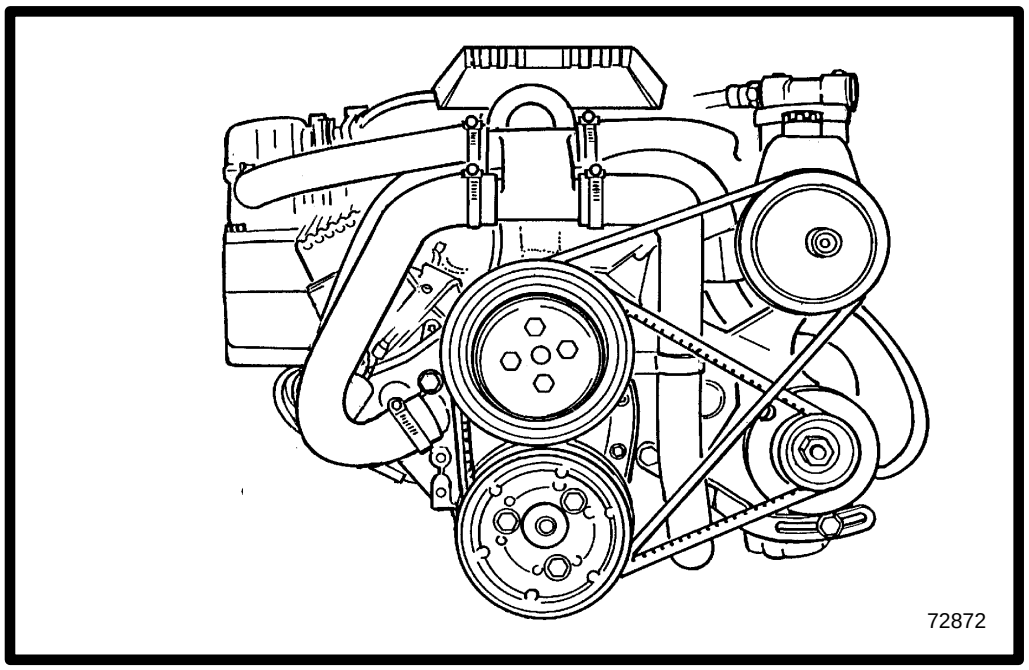
9. Connect battery cables to battery by FIRST connecting positive (+) battery cable (usually RED) to positive (+) battery terminal. Tighten clamp securely. Then, connect negative (–) battery cable (usually BLACK) to negative (–) battery terminal. Tighten clamp securely.

NOTE: *Spray terminals with a battery connection sealant to help retard corrosion.*

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

ENGINE

3
A



262 CID (4.3L)

Index

Table of Contents

Page

Torque Specifications 4.3L/4.3LX Engines . . . 3A-1
Tools/Lubricants/Sealants . . . 3A-3
Engine Specifications . . . 3A-4
General . . . 3A-14
- Engine Identification . . . 3A-14
- Cylinder Head Identification . . . 3A-14
- Crankshaft . . . 3A-15
- Piston and Connecting Rods . . . 3A-15
- Camshaft and Drive . . . 3A-15
- Balance Shaft . . . 3A-15
- Cylinder Head . . . 3A-15
- Valve Train . . . 3A-15
- Intake Manifold . . . 3A-15
- Lubrication System . . . 3A-16

Bearing Failures . . . 3A-17
Piston Failures . . . 3A-17
- Pre-Ignition . . . 3A-17
- Detonation . . . 3A-18

Engine Mounts . . . 3A-19
Rocker Arm Cover . . . 3A-19
- Removal . . . 3A-19
- Installation . . . 3A-19

Intake Manifold . . . 3A-20
Rocker Arm/Push Rod . . . 3A-22
- Removal . . . 3A-22
- Cleaning and Inspection . . . 3A-22
- Installation . . . 3A-22

Hydraulic Roller Valve Lifters . . . 3A-22
- Locating Noisy Lifters . . . 3A-23
- Removal . . . 3A-23
- Cleaning and Inspection . . . 3A-24
- Installation . . . 3A-24

Valve Stem Oil Seal/Valve Spring . . . 3A-25
- Removal - Head Installed . . . 3A-25
- Valve Assembly (Exploded View) . . . 3A-25
- Installation - Head Installed . . . 3A-26

Cylinder Head . . . 3A-26
- Removal . . . 3A-26
- Cleaning and Inspection . . . 3A-26
- Installation . . . 3A-27

Cylinder Head and Valve Conditioning . . . 3A-27
- Disassembly . . . 3A-27
- Cleaning . . . 3A-28
- Inspection . . . 3A-28
- Valve Guide Bore Repair . . . 3A-29
- Valve Springs - Checking Tension . . . 3A-29
- Valve Seat Repair . . . 3A-30
- Valve Grinding . . . 3A-30
- Reassembly . . . 3A-31

Dipstick Specifications . . . 3A-32
- All Engines . . . 3A-32

Oil Pan . . . 3A-33
- Removal . . . 3A-33
- Installation . . . 3A-33
- Reassembly . . . 3A-34

Oil Pump . . . 3A-33
- Removal . . . 3A-34
- Disassembly . . . 3A-34
- Cleaning and Inspection . . . 3A-34

Page

- Installation . . . 3A-35

Torsional Damper . . . 3A-35
- Removal . . . 3A-35
- Installation . . . 3A-35

Crankcase Front Cover/Oil Seal . . . 3A-36
- Oil Seal Replacement (Without Removing Front Cover) . . . 3A-36

Crankcase Front Cover . . . 3A-37
- Removal . . . 3A-37
- Cleaning and Inspection . . . 3A-37
- Installation . . . 3A-37

Flywheel . . . 3A-38
- Removal . . . 3A-38
- Inspection . . . 3A-38
- Installation . . . 3A-38

Rear Main Oil Seal . . . 3A-39
- Removal . . . 3A-39
- Cleaning and Inspection . . . 3A-39
- Installation . . . 3A-40

Rear Main Oil Seal Retainer . . . 3A-40
- Removal . . . 3A-40
- Cleaning and Inspection . . . 3A-40
- Installation . . . 3A-40

Main Bearings . . . 3A-40
- Inspection . . . 3A-41
- Checking Clearances . . . 3A-41
- Replacement . . . 3A-42

Connecting Rod Bearings . . . 3A-43
- Inspection and Replacement . . . 3A-43

Connecting Rod/Piston Assembly . . . 3A-44
- Removal . . . 3A-44
- Disassembly . . . 3A-45
- Cleaning and Inspection . . . 3A-45
- Reassembly . . . 3A-46
- Installation . . . 3A-47

Crankshaft . . . 3A-48
- Removal . . . 3A-48
- Cleaning and Inspection . . . 3A-49
- Installation . . . 3A-49

Timing Chain and Sprocket . . . 3A-50
- Removal . . . 3A-50
- Cleaning and Inspection . . . 3A-50
- Installation - Timing Chain . . . 3A-50

Crankshaft Sprocket . . . 3A-51
- Removal . . . 3A-51
- Installation . . . 3A-51
- Checking Timing Chain Deflection . . . 3A-51

Balance Shaft/Gears . . . 3A-52
- Removal . . . 3A-52
- Cleaning and Inspection . . . 3A-53
- Installation . . . 3A-53

Camshaft . . . 3A-54
- Measuring Lobe Lift . . . 3A-54
- Removal . . . 3A-55
- Inspection . . . 3A-55
- Installation . . . 3A-55

Camshaft Bearings . . . 3A-55
- Removal . . . 3A-55
- Inspection . . . 3A-56
- Installation . . . 3A-56

Cylinder Block . . . 3A-57
- Cleaning and Inspection . . . 3A-57

Oil Filter By-Pass Valve . . . 3A-60
- Inspection and/or Replacement . . . 3A-60

Index

Torque Specifications 4.3L/4.3LX Engines

NOTE: *Any Differences in Gen + Engines Will Be Noted With* **"Gen +".**

DESCRIPTION	Lb. In.	Lb. Ft.	N·m
Alternator Brace to Alternator	192		28
Alternator Brace to Engine		30	41
Alternator to Mounting Bracket		35	48
Alternator Mounting Bracket		30	41
Balance Shaft Drive Gear Retaining Stud	120		14
Balance Shaft Driven Gear Bolt **(Torque Plus 35°)**		15	20
Balance Shaft Thrust Plate	120		14
Camshaft Sprocket		20	27
Camshaft Thrust Plate	106		12
Carburetor	132		15
Connecting Rod Cap Nuts **(Torque Plus 60°)**		20	27
Connecting Rod Cap Nuts **Gen + (Torque Plus 70°)**			
Coupler/Flywheel		35	48
Crankcase Front Cover	124		14
Crankshaft Pulley Bolt (Cast Aluminum)		40	54
Cylinder Head Bolts		65	88
Cylinder Head Bolts **Gen +** First Sequence		22	30
Angle Torque Second Sequence Short Bolt		55 Degrees	
Medium Bolt		65 Degrees	
Long Bolt		75 Degrees	
Distributor Hold Down		25	34
Exhaust Manifold		20	27
Flywheel		75	100
Flywheel Housing to Block		30	41
Flywheel Housing Cover	80		9
Front Mount Bracket		30	41
Fuel Filter Bracket Bolt		25	25
Fuel Pump Bracket Bolt		25	25
Fuel Pump Inlet Fitting (Large Diameter See Note)	96		10.8
Fuel Pump Inlet Fitting (Small Diameter See Note)	84		9.6
Intake Manifold Bolts		35	48
Intake Manifold Bolts **Gen +**		11	15
Knock Sensor		15	20

NOTE: *Hold fuel pump using flat surface at outlet before tightening brass fitting.*

Torque Specifications 4.3L/4.3LX Engines (continued)

DESCRIPTION	Lb. In.	Lb. Ft.	N·m
Main Bearing Cap		75	100
Oil Filter Adapter Bolts		15	20
Oil Pan Drain Plug		15	20
Oil Pan Screw (1/4-20)	80		9
Oil Pan Nuts (5/16-20)	165		19
Oil Pump		65	68
Oil Pump Cover	80		9
Power Steering Pump Brace to Block		30	41
Power Steering Pump Bracket		30	41
Rear Crankshaft Oil Seal Retainer Screws and Nuts	133		15
Rear Mount (MCM)		40	54
Rocker Arm Cover	50		5.5
Rocker Arm Cover **Gen +**	106		12
Rocker Arm Nuts		20	27
Roller Lifter Restrictor Plate		12	16
Seawater Pump Brace (if equipped)		30	41
Seawater Pump Bracket (if equipped)		30	41
Spark Plugs		15	20
Starter Motor		50	68
Thermostat Housing		30	41
Torsional Damper		40	54
Water Circulating Pump		30	41
Water Temperature Sender		20	27

Note : Hold fuel pump using wrench on flat surface at outlet before tightening brass fitting

Tools/Lubricants/Sealants

Mercury Marine	
Part Number	**Description**
91-24697	Piston Ring Expander
91-35547	Engine Coupler Wrench
92-823089 - 1	Quicksilver Loctite 8831
92-91601-1	Quicksilver RTV Sealer
92-34227--1	Quicksilver Perfect Seal

Snap-On Special Tools (see note)	
Part Number	**Description**
TA 360	Torque Angle Gauge (Degree Wheel Torquing)

NOTE: *Snap-On Tools can be ordered from your nearest Snap-On branch sales office or distributor.*

Lubricant Obtained Locally	
Part Number	**Description**
Obtain Locally	General Motors Cam and lifter Prelube or Equivalent

Kent-Moore Special Tools (see note)	
Part No.	**Description**
J5892	Valve Spring Compressor
J8062	Valve Spring Compressor
J8056	Valve Spring Tester
J8101	Valve Guide Cleaner
J5830-2	Valve Guide Reamer
J7049	Valve Guide Reamer
J8089	Carbon Remover Brush
J24086-B	Piston Pin Remover Kit
J3936-03	Piston Ring Groove Cleaner
J8037	Piston Ring Compressor
J5239	Connecting Rod Bolt Guide Set (3/8-24)
J21882	Oil Pump Suction Pipe Installer
J6098-01	Camshaft Bearing Remover and Installer Set
J8520-1	Ball Socket Adaptor Tool Kit (Lift Indicator)
J23523-E	Torsional Damper Remover and Installer
J35468	Crankcase Front Cover Seal Installer
J5825-A	Crankshaft Gear and Sprocket Puller
J5590	Crankshaft Gear and Sprocket Installer
J23590	Air Adaptor
J8080	Main Bearing Remover/Installer
J26817-A	Rear Main Seal Installer
J26941	Balance Shaft Rear Bearing Remover
J33834	Balance Shaft Bearing Remover/Installer

NOTE: *Kent-Moore Special Tools can be ordered from:*

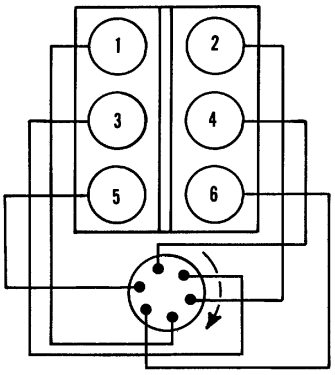
Kent-Moore Tools Inc.
29784 Little Mack
Roseville, MI 48066
Phone: (800) 345-2233.

Engine Specifications

UNIT OF MEASUREMENT In. (mm)

Engine Model	4.3L/4.3LX
Displacement	262 CID (4.3 Litre)
Bore	4.00 (101.6)
Stroke	3.48 (88.39)
Compression Ratio	9.05:1 (**Gen +** - 9.4:1)
Heads	Cast Iron
Intake manifold	Cast Iron
Block	Cast Iron (2 Bolt Main Bearing Caps)
Rods	Forged Steel
Pistons	Cast Aluminum
Crankshaft	Cast Iron
Camshaft	Steel

LH ROTATION
FRONT



Firing Order
1-6-5-4-3-2

72976

262 CID / 4.3L Engine Specifications (Does Not Include Gen +)

CYLINDER BORE

Diameter			4.0007-4.0017 (101.6178-1016431)
Out-of-Round		Production	.001 (0.025) Maximum
		Service	.002 (0.051) Maximum
Taper	Production	Thrust Side	.0005 (0.0127) Maximum
		Relief Side	.001 (0.025) Maximum
	Service		.001 (0.025) Over Production

PISTON

Clearance	Production	.0007-.0017 (0.0178-0.0431)
	Service	.0027 (0.07) Maximum

PISTON RING

Compression	Groove Side Clearance	Production	Top	.0012-.0032 (0.0305-0.0813)
			2nd	.0012-.0032 (0.0305-0.0813)
		Service		High Limit Production + .001 (0.025)
	Gap	Production	Top	.010-.025 (0.254-0.508)
			2nd	.010-.025 (0.254-0.508)
		Service		High Limit Production + .010 (0.254)
Oil	Groove Side Clearance	Production		.002-.007 (0.051-0.177)
		Service		High Limit Production + .001 (0.025)
	Gap	Production		.015-.055 (0.381-1.397)
		Service		High Limit Production + .010 (0.254)

PISTON PIN

Diameter		.9270-.9273 (23.5458-23.5534)
Clearance in Piston	Production	.0002-.0007 (0.0051-0.0177)
	Service	.001 (0.025) Maximum
Fit in Rod		.0008-.0016 (0.0203-0.0406) Interference

262 CID / 4.3L Engine Specifications (Does Not Include Gen +)

CRANKSHAFT

Main Journal	Diameter	No. 1	2.4484-2.4493 (62.1894-62.2122)
		No. 2, 3	2.4481-2.4490 (62.1817-62.2046)
		No. 4	2.4479-2.4488 (62.1767-62.1995)
	Taper	Production	.0002 (0.005) Maximum
		Service	.001 (0.02) Maximum
	Out-of-Round	Production	.0002 (0.005) Maximum
		Service	.001 (0.02) Maximum
Main Bearing Clearance	Production	No. 1	.0008-.0020 (0.0203-0.0508)
		No. 2, 3	.0011-.0023 (0.0279-0.0584)
		No. 4	.0017-.0032 (0.0432-0.0813)
	Service	No. 1	.0010-.0015 (0.03)
		No. 2, 3	.0010-.0025 (0.3-0.06)
		No. 4	.0025-.0035 (0.07-0.08)
Crankshaft End Play			.002-.006 (0.05-0.15)
Connecting Rod Journal	Diameter		2.2487-2.2497 (57.1170-57.1423)
	Taper	Production	.0005 (0.0127) Maximum
		Service	.001 (0.02) Maximum
	Out-of-Round	Production	.0005 (0.0127) Maximum
		Service	.001 (0.02) Maximum
Rod Bearing Clearance		Production	.0013-.0035 (0.0330-0.0889)
		Service	.003 (0.07) Maximum
Rod Side Clearance			.006-.014 (0.152-0.356)
Crankshaft Runout			.0015 (0.0381) Maximum

262 CID / 4.3L Engine Specifications (Does Not Include Gen +)

VALVE SYSTEM

Lifter Type			Roller Hydraulic
Rocker Arm Ratio			1.50 to 1
Valve Lift		Intake	.394 (10.00)
		Exhaust	.404 (10.26)
Valve Lash (Intake and Exhaust)			Fixed Lash
Face Angle (Intake and Exhaust)			45°
Seat Angle (Intake and Exhaust)			46°
Seat Runout (Intake and Exhaust)			.002 (0.051) Maximum
Seat Width		Intake	.031-.062 (0.8-1.6)
		Exhaust	.062-.091 (1.6-2.3)
Stem Clearance	Production	Intake	.0010-.0027 (0.0254-0.0686)
		Exhaust	
	Service	Intake	.0037 (0.09)
		Exhaust	.0047 (0.11)
Stem Diameter		Intake	.341 (8.66)
		Exhaust	.372 (9.45)
Valve Diameter		Intake	1.94 (49.28)
		Exhaust	1.50 (38.1)
Valve Margin Intake and Exhaust			1/32 (0.79)

262 CID / 4.3L Engine Specifications (Does Not Include Gen +)

VALVE SPRING

Valve Spring	Free Length		2.03 (51.6)
	Pressure	Closed at 1.70 (43.16)	76-84 Lbs. (338-374 N)
		Open at 1.25 (31.75)	194-206 Lbs. (863-916 N)
	Installed Height		1.70 (43)
Damper	Free Length		1.86 (47)
	Approximate Number of Coils		4

NOTE: *Test spring pressure with damper removed*

CAMSHAFT AND DRIVE

Lobe Lift ± .002 (0.051)	Intake	.269 (6.892)
	Exhaust	.273 (6.934)
Journal Diameter		1.8682-1.8692 (47.452-47.478)
Journal Out-of-Round		.001 (0.025) Maximum
Cam Shaft Runout		.002 (0.051) Maximum
Camshaft End Play		.004 -.012 (0.11-0.30) Maximum
Timing Chain Deflection		3/8 (10) From Taut Position [3/4 (19) Total]

FLYWHEEL

Runout	.008 (0.203) Maximum

CYLINDER HEAD

Gasket Surface Flatness	.004 (0.10) Overall Maximum

BALANCE SHAFT

Front Bearing Journal		1.1812-1.815 (30.002-30.010)
Rear Bearing Journal		1.4209-1.4215 (36.091-36.301)
Rear Bearing Inside Diameter Assembled	Production	1.5014-1.503 (37.525-37.575)
Rear Bearing Outside Diameter	Production	1.875-1.876 (46.875-46.900)
Rear Cylinder Block Housing Bore	Production	1.873-1.874 (46.825-46.850)

262 CID / 4.3L Gen + Engine Specifications

Unit of Measurement in. (mm)

CYLINDER BORE

Diameter			4.0007-4.0017 (101.618-101.643)
Out of Round		Production	.001 (0.025) Maximum
		Service	.002 (0.051) Maximum
Taper	Production	Thrust Side	.0005 (0.012) Maximum
		Relief Side	.001 (0.025) Maximum
	Service		.001 (0.025) Maximum

PISTON CLEARANCE

Production	.0007-.002 (0.017-0.05)
Service	.0024 (.001)

PISTON RING: COMPRESSION (MEASURED IN CYLINDER BORE)

Groove Clearance	Production	Top	.02-.06 (0.51-1.52)
		2nd	.04-.08 (1.02-2.03)
	Service		.0042 (0.107) Maximum
Gap	Production	Top	.010-.016 (0.25-0.40)
		2nd	.018-.026 (.046-.066) Maximum
	Service		0.06-0.035 (1.524-0.88) Maximum

PISTON RING: OIL

Groove Clearance	Production	.002-.007 (0.51-0.20)
	Service	0.02-0.08 (0.51-2.032)
Gap	Production	.015-.050 (0.38-1.27)
	Service Limit	0.009-0.065 (0.23-1.65)

PISTON PIN

Diameter		.9267-.9271 (23.545-23.548)
Clearance	Production	.0002-.0007 (0.005-0.0178)
	Service Limit	.001 (0.025) Maximum
Fit in Rod		.0008-.0016 (0.021-0.040) Interference

262 CID / 4.3L Engine Gen + Specifications

Unit of Measurement in. (mm)

CRANKSHAFT

Main Journal	Diameter	No.1	2.4488-2.4495 (62.199-62.217)
		No. 2, 3	2.4485-2.4494 (62.191-62.215)
		No.4	2.4479-2.4489 (62.179-62.203)
	Taper	Production	.0003 (0.007) Maximum
		Service	.001 (0.025) Maximum
	Out of Round	Production	.0002 (0.005) Maximum
		Service	.001 (0.025) Maximum
Main Bearing Clearance	Production	No.1	.0008-.0020 (0.020-0.051)
		No.2, 3, 4	.0010-.025 (0.025-0.635)
	Service	No.1, 2, 3, 4	.0010-.0020 (0.03-0.051)
Crankshaft End Play			.002-.008 (0.05-0.20)
Connecting Rod Journal	Diameter		2.2487-2.2497 (57.117-57.142)
	Taper	Production	.0003 (0.007) Maximum
		Service	.001 (0.025) Maximum
	Out of Round	Production	.0002 (0.0051) Maximum
		Service	.001 (0.025) Maximum
Rod Bearing Clearance		Production	.0013-.0035 (0.033-0.088)
		Service	.0010-.0030 (0.025-0.076)
Rod Side Clearance			.006-.017 (0.15-0.43)
Crankshaft Runout			.001 (0.025) Maximum

262 CID / 4.3L Gen + Engine Specifications

Unit of Measurement in. (mm)

VALVE SYSTEM

Lifter			Hydraulic Roller
Rocker Arm Ratio			1.50 to 1
Valve Lift		Intake	.414 (10.52)
		Exhaust	.428 (10.87)
Valve Lash (Intake and Exhaust)			Net Lash No Adjustment
Face Angle (Intake & Exhaust)			45°
Seat Angle (Intake & Exhaust)			46°
Seat Runout (Intake & Exhaust)			.002 (0.05) Maximum
Seat Width		Intake	.035-.060 (0.89-1.52)
		Exhaust	.062-.093 (1.58-2.38)
Stem Clearance	Production	Intake	.0010-.0027 (0.025-0.069)
		Exhaust	
	Service	Intake	.001 (0.025) Maximum
		Exhaust	.002 (0.51) Maximum
Stem Diameter		Intake	.3400-.3407 (8.636-8.653)
		Exhaust	
Valve Margin Intake and Exhaust			.031 (0.79)

VALVE SPRING

Valve Spring	Free Length		2.03 (51.6)
	Pressure	Valve Closed	76-84 Lb. (338-374 N) at 1.7 in (43.16 mm)
		Valve Open	187-203 Lb. (832-903 N) at 1.27 in (32.25 mm)
	Installed Height		1.690-1.710 in (42.93-43.43 mm)

262 CID / 4.3L Gen + Engine Specifications

Unit of Measurement in. (mm)

CAMSHAFT AND DRIVE

Lobe Lift ± .002(0.051)	Intake	.286-.290 (7.26-7.36)
	Exhaust	.292-.296 (7.42-7.52)
Journal Diameter		1.8682-1.8692 (47.452-47.478)
Journal Out of Round		.001 (0.025) Maximum
Camshaft Runout		.002 (0.051) Maximum
Camshaft End Play		.001-.009 (0.0254-0.2286)
Timing Chain Deflection		.375(9.5) from taut position [total .75 (19)]

FLYWHEEL

Runout	.008 (0.203) Maximum

CYLINDER HEAD

Gasket Surface Flatness	.010 (0.254) Overall Maximum

BALANCE SHAFT

Front Bearing Journal	2.1648-2.1654 (54.985-55.001)
Rear Bearing Journal	1.4994-1.500 (38.084-38.100)
Rear Bearing Journal Clearance	.001-.0036 (.025-.091)

262 CID / 4.3L Gen + Engine Specifications

Unit of Measurement in. (mm)

CAMSHAFT AND DRIVE

Lobe Lift ± .002(0.051)	Intake	.286-.290 (7.26-7.36)
	Exhaust	.292-.296 (7.42-7.52)
Journal Diameter		1.8682-1.8692 (47.452-47.478)
Journal Out of Round		.001 (0.025) Maximum
Camshaft Runout		.002 (0.051) Maximum
Camshaft End Play		.001-.009 (0..0254-0.2286)
Timing Chain Deflection		.375(9.5) from taut position [total .75 (19)]

FLYWHEEL

Runout	.008 (0.203) Maximum

CYLINDER HEAD

Gasket Surface Flatness	.010 (0.254) Overall Maximum

BALANCE SHAFT

Front Bearing Journal		2.1648-2.1654 (55.985-55.001)
Rear Bearing Journal		1.4994-1.500 (38.084-38.100)
Rear Bearing Inside Diameter Assembled	Production	1.5014-1.503 (37.525-37.575)
Rear Bearing Outside Diameter	Production	1.875-1.876 (46.875-46.900)
Rear Cylinder Block Housing Bore	Production	1.873-1.874 (46.825-46.850)

General

Some of the repairs in this section must be completed with engine removed from boat. Engine removal depends upon type of repair and boat design. Place engine on repair stand for major repairs.

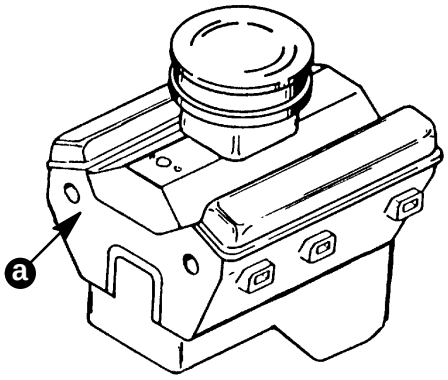
When engine removal is not required, make certain that battery cables are disconnected at the battery prior to performing any on-board engine repair procedure.

Lubricate all moving parts (during reassembly) with engine oil. Apply Quicksilver Perfect Seal on threads of and under heads of cylinder head bolts, and on threads of all cylinder block external bolts, screws and studs.

Engine Identification

The MerCruiser Model can be determined by looking at the last two letters of the engine code stamped into the cylinder block. This code number is stamped on all MerCruiser power packages and replacement partial engines, but not replacement cylinder block assemblies.

If the engine serial number and/or model decals are missing, the engine code letters may help in determining the engine models.

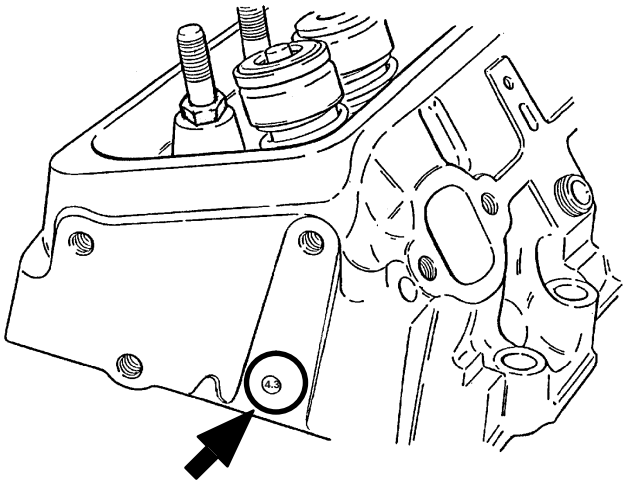


72873

a - Location of GM Engine Code (Front Starboard Side, Near Cylinder Head Mating Surface)

MCM (Stern Drive)	Code	Rotation
4.3L Alpha	LG, LJ, LK	LH
4.3LX Alpha	LH	
4.3LX Gen + Alpha and Bravo Three	LJ	
4.3LXH Gen + Alpha and Bravo	LK	
262 Magnum EFI Gen +		

Cylinder Head Identification

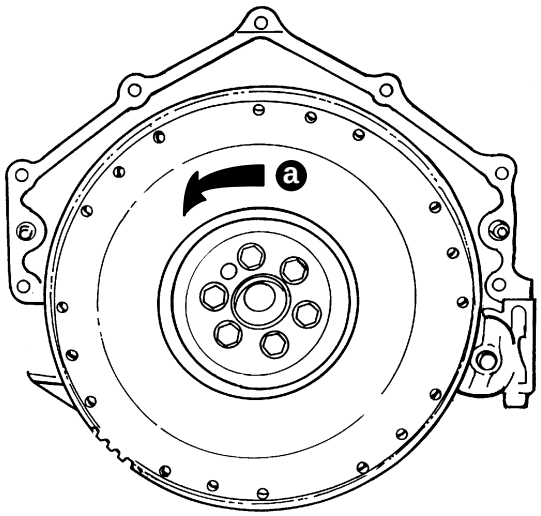


72875

Engine Rotation

Engine rotation terminology at times has caused confusion. To clarify, engine rotation is determined by observing flywheel rotation from the rear (transmission or stern drive end) of the engine looking forward (water pump end).

PROPELLER ROTATION IS NOT NECESSARILY THE SAME as engine rotation. Do not rely on propeller rotation in determining engine rotation.



72001

a - Left Hand Rotation (CCW) - All Stern Drive Engines

Crankshaft

The crankshaft is supported in the block by four insert type bearings. Crankshaft end thrust is controlled by flanges on the No. 4 bearing. A torsional damper on the forward end of the crankshaft serves to help dampen any engine torsional vibration.

Piston and Connecting Rods

Piston pins are offset slightly toward the thrust side of the pistons to provide a gradual change in thrust pressure against the cylinder wall as the piston travels its path. Pins have a floating fit in the piston and a press fit in the connecting rod (to hold them in place).

Connecting rods are made of forged steel and are connected to the crankshaft through insert type bearings.

Camshaft and Drive

Camshafts are generally made of cast iron, except on engines with roller lifters which have camshafts made of steel. All camshafts are driven at one-half crankshaft speed by a timing chain and sprockets, and are supported by four main bearings, which are pressed into the block.

A helical gear on the aft end of the camshaft drives the distributor and oil pump.

Balance Shaft

The balance shaft is located in the engine block valley directly above and parallel to the camshaft. The balance shaft extends the entire length of the engine and is supported on each end by a bearing. It is also driven by the camshaft through a helical gear set. The function of the balance shaft is to equalize the dynamic forces inherent in particular engine designs, thus minimizing engine vibration.

Cylinder Head

The cylinder heads are made of cast iron and have individual intake and exhaust ports for each cylinder.

Stainless steel or graphite composition head gaskets are used to retard corrosion.

Valve Train

The valves and valve springs are of a heavy-duty design to withstand the high engine speeds encountered. Valve tips have been hardened to extend valve life. Exhaust valve rotators are used to help extend valve life.

Hydraulic valve roller lifters ride directly on the camshaft lobes and transmit the thrust of the lobes to the push rods which in turn actuate the valves through the rocker arm.

In addition to transmitting thrust of the cam lobes, the hydraulic lifters also serve to remove any clearance (lash) from the valve train to keep all parts in constant contact.

The roller lifters are restrained from rotating by two retainers (restrictors) located in the valley. The valve lifters also are used to lubricate the valve train bearing surfaces.

Intake Manifold

The manifold is of the single level design for efficient fuel distribution. All passages are of approximately equal length to assure more even fuel-air mixture to the cylinders.

Lubrication System

The engine lubrication system is of the force-feed type in which oil is supplied under full pressure to the crankshaft, connecting rods, camshaft bearings and valve lifters, and is supplied under controlled volume to the push rods and rocker arms. All other moving parts are lubricated by gravity flow or splash.

A positive displacement gear-type oil pump is mounted on the rear main bearing cap and is driven by an extension shaft from the distributor (which is driven by the camshaft). Oil from the bottom of the pump in the rear of the oil pan is drawn into the oil pump through an oil pickup screen and pipe assembly.

If the screen should become clogged, a relief valve in the screen will open and continue to allow oil to be drawn into the system. Once the oil reaches the pump, the pump forces the oil through the lubrication system. A spring-loaded relief valve in the pump limits the maximum pump output pressure.

After leaving the pump, the pressurized oil flows through a full-flow oil filter. On engines with an engine oil cooler, the oil also flows through the cooler before returning to the block. A bypass valve allows oil to bypass the filter and oil cooler should they become restricted.

Some of the oil, after leaving the oil cooler and/or filter, is routed to the No. 4 crankshaft main bearing. The remainder of the oil is routed to the main oil gallery, which is located directly above the camshaft and runs the entire length of the block. From the main oil gallery, the oil is routed through individual oil passages to an annular groove in each camshaft bearing bore. Some of the oil is then used to lubricate camshaft bearings. The remainder of the oil is routed to the valve lifter oil galleries and No. 1, 2 and 3 crankshaft main bearings by means of individual oil passages which intersect with the annular grooves.

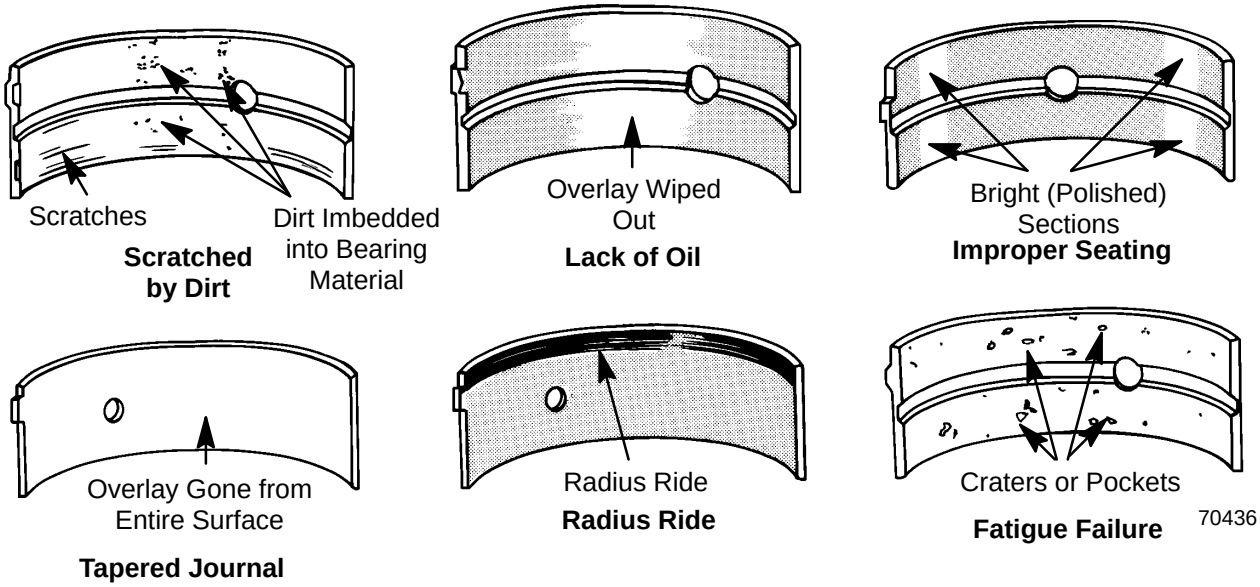
The camshaft bearings have holes which align with the oil passages or annular grooves in the block and allow oil to flow in-between the bearings and the camshaft journals. The oil that is forced out the front end of the No. 1 camshaft bearing drains down onto the camshaft drive and keeps it lubricated.

The oil which reaches the crankshaft main bearings is forced through a hole in the upper half of each bearing and flows in-between the bearings and the crankshaft journals. Some of the oil is then routed to the connecting rod bearings through grooves in the upper half of the crankshaft main bearings and oil passages in the crankshaft. Oil which is forced out the ends of the connecting rod bearings and crankshaft main bearings is splashed onto the camshaft, cylinder walls, pistons and piston pins, keeping them lubricated. Oil which is forced out the front end of the No. 1 crankshaft main bearing also assists in lubricating the camshaft drive.

Oil which reaches the valve lifter oil galleries is forced into each hydraulic valve lifter through holes in the side of the lifter. From here, the oil is forced through the metering valve in each of the lifters (which controls the volume of oil flow) and then up through the push rods to the rocker arms. A hole in each rocker arm push rod seat allows the oil to pass through the rocker arm and lubricate the valve train bearing surfaces. After lubricating the valve train, oil drains back to the oil pan through oil return holes in the cylinder head and block.

The distributor shaft and gear also is lubricated by the oil flowing through the right valve lifter oil gallery.

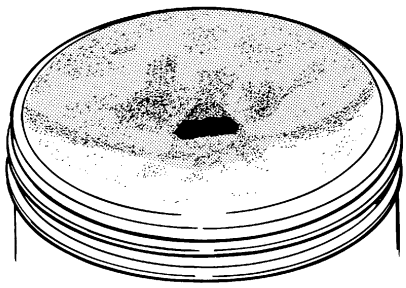
Bearing Failures



Piston Failures

Pre-Ignition

Pre-ignition is abnormal fuel ignition, caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion on the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature.



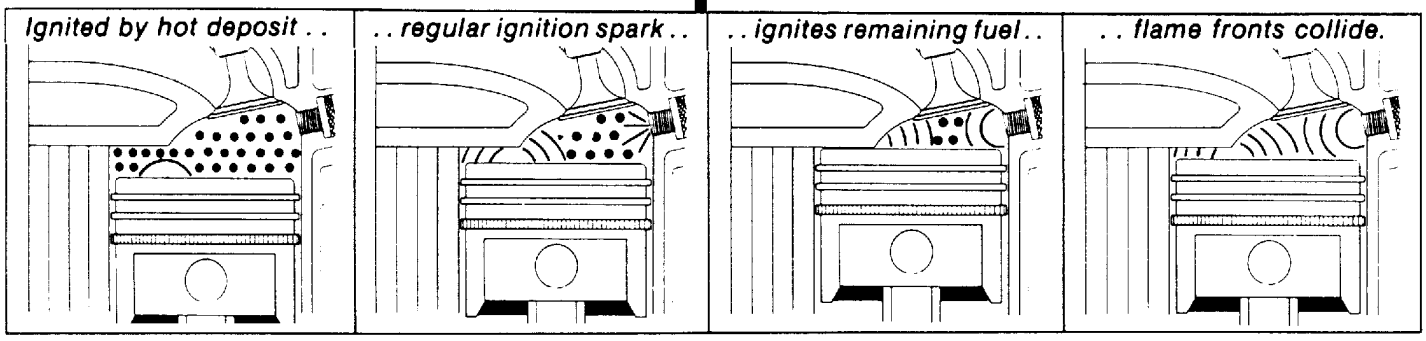
72424

Pre-Ignition Damage

PRE-IGNITION CAUSES

1. Hot spots in the combustion chamber from glowing deposits (due in turn to the use of improper oils and/or fuels).
2. Overheated spark plug electrodes (improper heat range or defective plug).
3. Any other protuberance in the combustion chamber, such as an overhanging piece of gasket, an improperly seated valve or any other inadequately cooled section of material which can serve as a source.

Engine failures, which result from the foregoing conditions, are beyond the control of Mercury Marine; therefore, no warranty will apply to failures which occur under these conditions.



72314

Detonation

Detonation, commonly called “fuel knock,” “spark knock” or “carbon knock,” is abnormal combustion of the fuel which causes the fuel to explode violently. The explosion, in turn, causes overheating or damage to the spark plugs, pistons, valves and, in severe cases, results in pre-ignition.

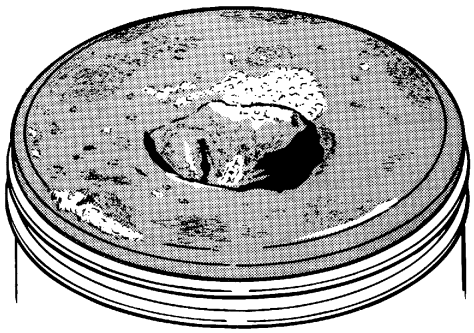
Use of low octane gasoline is one of the most common causes of detonation. Even with high octane gasoline, detonation could occur if engine maintenance is neglected.

OTHER CAUSES OF DETONATION

IMPORTANT: Use of improper fuels will cause engine damage and poor performance.

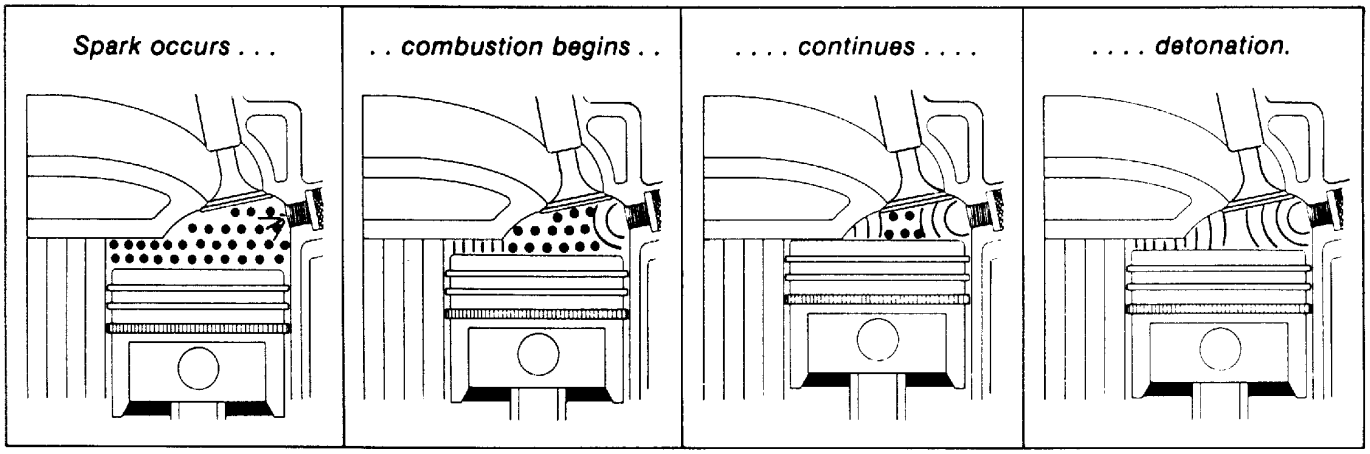
1. Over-advanced ignition timing.
2. Lean fuel mixture at or near full throttle (could be caused by carburetor or leaking intake manifold).
3. Cross-firing spark plugs.
4. Excess accumulation of deposits on piston and/or combustion chamber (results in higher compression ratio).
5. Inadequate cooling of engine by deterioration of cooling system.

Engine failures, which result from the foregoing conditions, are beyond the control of MerCruiser; therefore, no warranty will apply to failures which occur under these conditions.



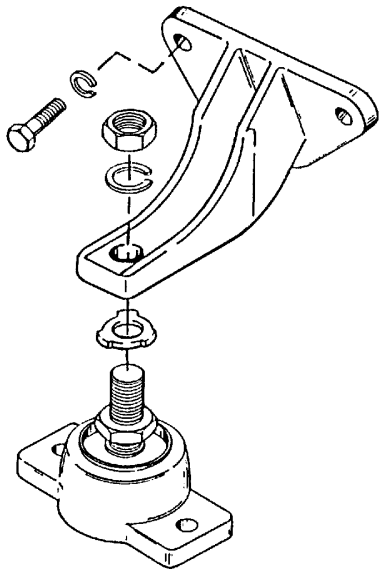
72425

Detonation Damage



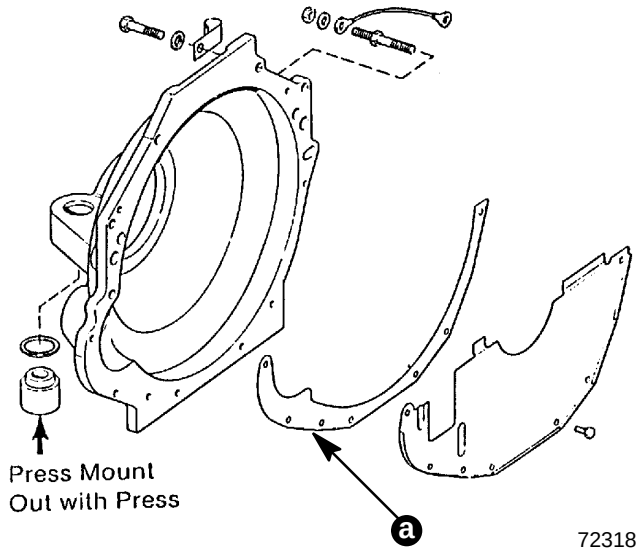
72315

Engine Mounts



72316

Front Mount



72318

Rear Mount/Flywheel Housing

a - Gasket Used on MCM Engines Only

Rocker Arm Cover

Removal

It may be necessary to remove exhaust manifold before removing rocker arm cover. Refer to Section 7B for removal.

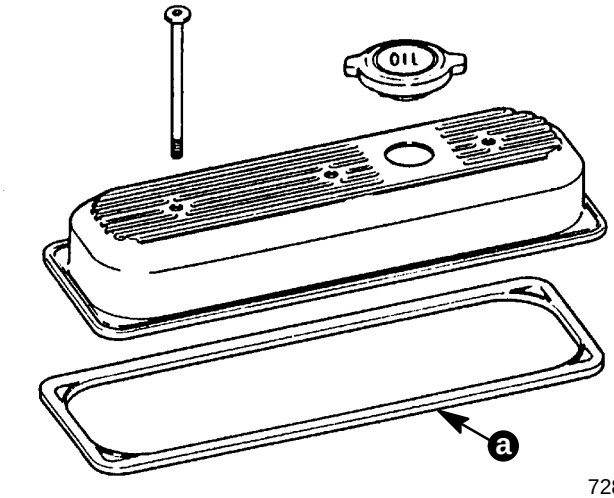
1. Disconnect crankcase ventilation hoses.
2. Remove any items that interfere with the removal of rocker arm covers.

IMPORTANT: DO NOT pry rocker arm cover loose. Gaskets, which may adhere to cylinder head and rocker arm cover, may be loosened by bumping end of rocker cover from the rear with palm of hand or a rubber mallet.

3. Remove rocker arm cover.

Installation

1. Clean sealing surfaces on cylinder head and rocker arm cover with degreaser.
2. Place new rocker arm cover gasket in position in rocker arm cover.



72874

a - Rocker Arm Cover Gasket

3. Install rocker arm cover. Torque screws to 50 lb. in. (5.5 N·m).
4. Install exhaust manifolds, if removed.
5. Install any items which were removed to allow removal of rocker arm covers.
6. Connect crankcase ventilation hoses to rocker arm covers.
7. Start engine and check for oil leaks.

Intake Manifold

Removal

1. Drain engine cooling system.
2. Disconnect hoses from thermostat housing.
3. Disconnect electrical leads interfering with removal.
4. Disconnect crankcase ventilation hoses from rocker arm covers.
5. Disconnect throttle cable from carburetor. Remove fuel line running between fuel pump and carburetor.
6. Remove distributor cap and mark position of rotor on distributor housing. Also, mark position of distributor housing on intake manifold. Remove distributor.

IMPORTANT: Do not crank engine over after distributor has been removed.

7. Remove other ignition components.
8. Remove oil sending unit.
9. Disconnect any other miscellaneous items that will prevent removal of manifold.

IMPORTANT: It may be necessary to pry intake manifold away from cylinder heads and block, in next step. Use extreme care to prevent damage to sealing surfaces.

10. Remove intake manifold bolts, then remove intake manifold and carburetor assembly.

NOTE: *If intake manifold requires replacement, transfer all remaining parts to new manifold.*

Cleaning and Inspection

1. Clean gasket material from all mating surfaces.

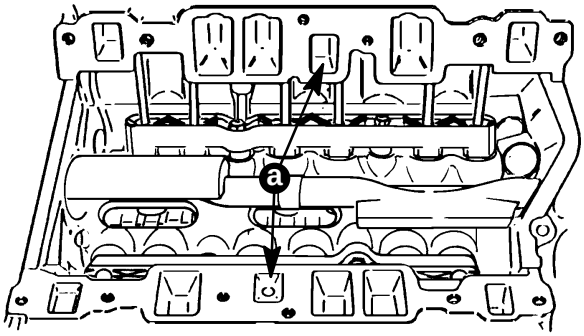
IMPORTANT: When cleaning cylinder head mating surface, do not allow gasket material to enter engine crankcase or cylinder head ports.

2. Inspect manifold for cracks or scratches. Machined surfaces must be clean and free of all marks and deep scratches or leaks may result.
3. Check intake passages for varnish buildup and other foreign material. Clean as necessary.

Installation

IMPORTANT: When installing intake manifold gaskets, in next step, observe the following:

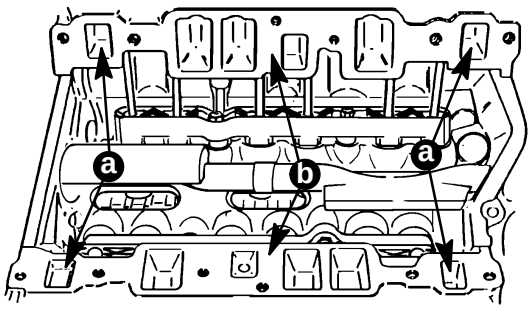
- **Be sure to install gasket with marked side up. Both gaskets are identical.**
- **On engines with 2 barrel carburetor, remove metal insert from manifold gasket to be used on starboard (right) cylinder head to provide clearance for heat pipe on intake manifold.**
- **All MerCruiser V-6 GM engines that have "automatic" carburetor chokes must use an intake gasket that has an opening for the exhaust crossover port in the intake manifold. Without this opening the "automatic" carburetor choke will not operate properly. The choke will remain ON longer causing rough engine operation and wasted fuel.**



71850

a - Exhaust Crossover Port Opening in Gasket

1. Apply Quicksilver Perfect Seal to intake manifold gaskets especially around coolant passages (both sides).
2. Place gaskets on cylinder heads.

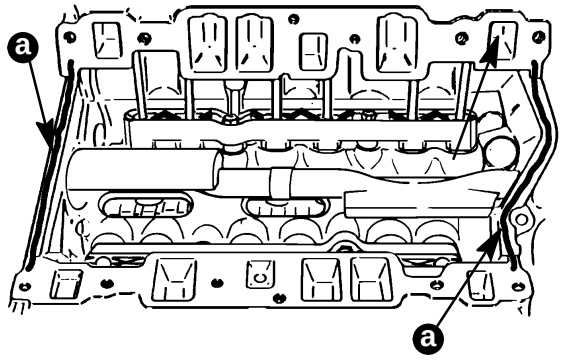


71850

a - Coolant Passages
b - Gaskets

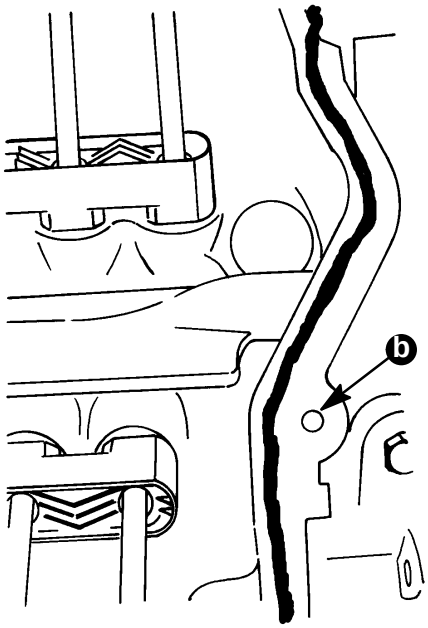
3. Apply a 3/16 in. (5 mm) wide bead of Quicksilver RTV Sealer to engine block as shown. Extend sealer 1/2 in. (13 mm) up on intake gaskets.

IMPORTANT: DO NOT get Quicksilver RTV Sealer into oil sending unit hole at rear of engine.



71850

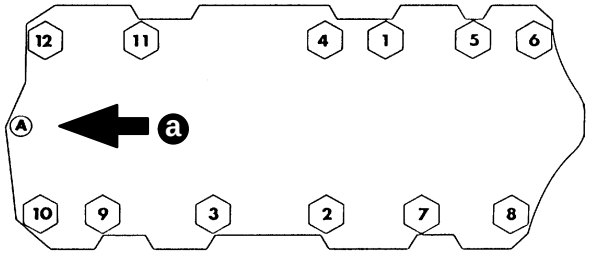
a - RTV Sealer (Typical Both Ends)



71851

b - Oil Sending Unit Hole

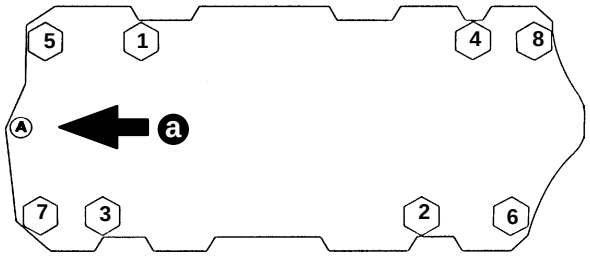
4. Carefully install manifold assembly and torque bolts to 35 lb. ft. (48 N·m) in sequence as shown.



72878

Intake Manifold Torque Sequence (All Engines Except Gen +)

a - Front



72878

Intake Manifold Torque Sequence (Gen + Engine Only)

a - Front

5. Connect all electrical leads.
6. Connect hoses to thermostat housing.
7. Install fuel line to carburetor and fuel pump.
8. Connect crankcase ventilation hoses to rocker arm covers.
9. Install distributor. Position rotor and housing to align with marks made during removal, then install distributor cap.
10. Install other ignition components and reconnect wires.
11. Coat threads of oil pressure sending unit with Quicksilver Perfect Seal and install.
12. Connect any other items which were disconnected from manifold during removal.
13. Start engine. Adjust ignition timing and carburetor. Check hose connections, gaskets and seals for leaks.
14. Inspect fuel line connections for fuel leaks.

Rocker Arm/Push Rod

Removal

NOTE: *When servicing only one cylinder's rocker arms, bring that cylinder's piston up to TDC before removing rocker arms. When servicing all rocker arms, bring No. 1 piston up to TDC before removing rocker arms.*

1. Remove rocker arm covers as outlined.
2. Remove rocker arm assemblies and push rods.

IMPORTANT: Place rocker arm assemblies and push rods in a rack for reassembly in their original locations.

Cleaning and Inspection

1. Clean parts with solvent and dry with compressed air.
2. Inspect all contact surfaces for wear. Replace all damaged parts.

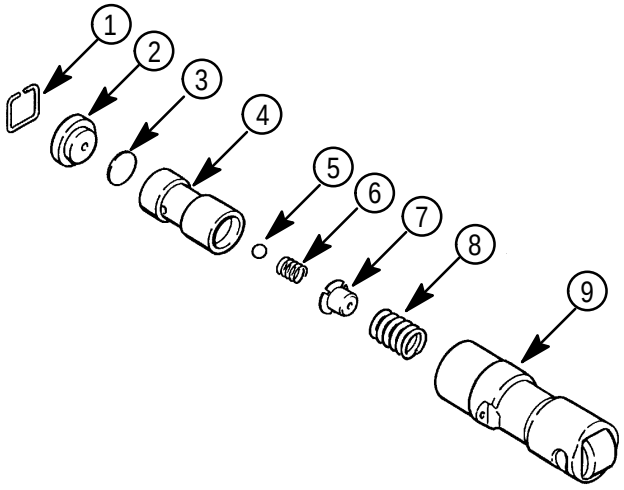
Installation

IMPORTANT: When installing rocker arms and rocker arm balls, coat bearing surfaces of rocker arms and rocker arm balls with engine oil.

1. Install push rods in their original locations. Be sure push rods seat in lifter socket.
2. Install rocker arms, rocker arm balls and rocker arm nuts in their original locations.
3. Torque rocker arm nuts to 20 lb. ft. (27 N·m). No valve adjustment is required. Valve lash is automatically set when rocker arm nuts are torqued to specification.

Hydraulic Roller Valve Lifters

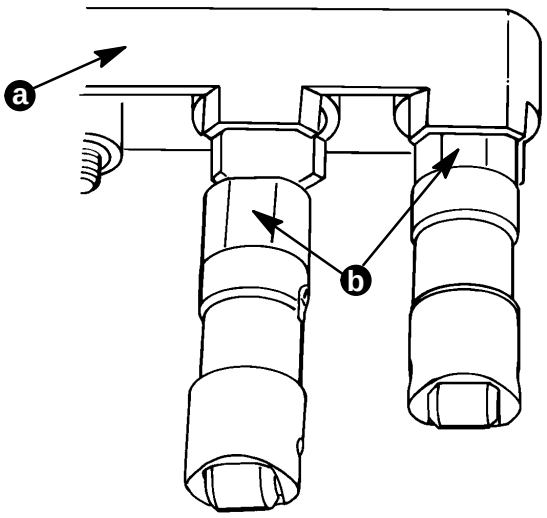
Hydraulic valve lifters require little attention. Lifters are extremely simple in design. Normally, readjustments are not necessary and servicing requires only that care and cleanliness be exercised in the handling of parts.



72031

1 - Push Rod Seat Retainer
2 - Push Rod Seat
3 - Metering Valve
4 - Plunger
5 - Check Ball
6 - Check Ball Spring
7 - Check Ball Retainer
8 - Plunger Spring
9 - Lifter Body

Valve lifters are retained in position and prevented from rotating by two valve retainers, one on each side of the engine beneath the intake manifold. Care should be exercised when installing the retainers to see that the flat portions of the lifters are properly positioned into the retainers.



71853

a - Retainer
b - Roller Lifter Flat Portion

Locating Noisy Lifters

Locate a noisy valve lifter by using a piece of garden hose approximately 4 ft. (1.2 m) in length. Place one end of hose near end of each intake and exhaust valve, with other end of hose to the ear. In this manner, sound is localized, making it easy to determine which lifter is at fault.

Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat.

General types of valve lifter noise are as follows:

1. Hard rapping noise - usually caused by plunger becoming tight in bore of lifter body so that return spring cannot push plunger back up to working position. Probable causes are:
   a. Excessive varnish or carbon deposit, causing abnormal stickiness.
   b. Galling or “pickup” between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedged between plunger and lifter body.
2. Moderate rapping noise - probable causes are:
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper adjustment.
3. General noise throughout valve train - this will, in most cases, be a definite indication of insufficient oil supply or improper adjustment.
4. Intermittent clicking - probable causes are:
   a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, ball itself may be out of round or have a flat spot.
   c. Improper adjustment.

In most cases, where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in solvent, reassembled and reinstalled in engine. If dirt, corrosion, carbon, etc., is shown to exist in one unit, it more likely exists in all the units; thus it would only be a matter of time before all lifters caused trouble.

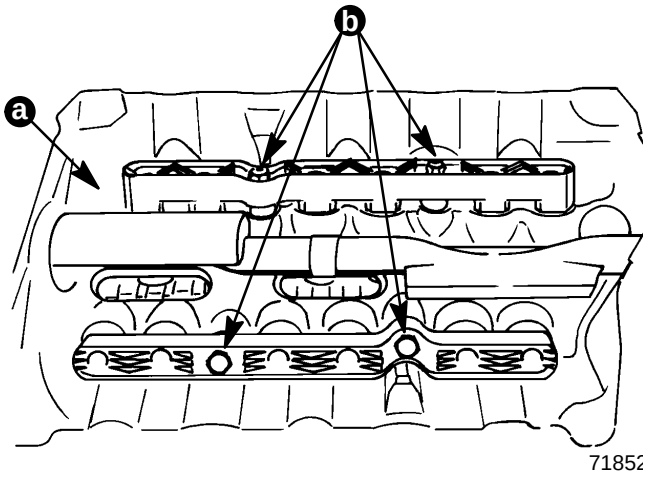
Removal

1. Remove as previously outlined:
   a. Rocker arm covers.
   b. Intake manifold.

IMPORTANT: Keep valve push rod and hydraulic lifter from each valve together as a matched set and mark or store them so they can be reinstalled in the same location later.

   c. Rocker arm assemblies and push rods.

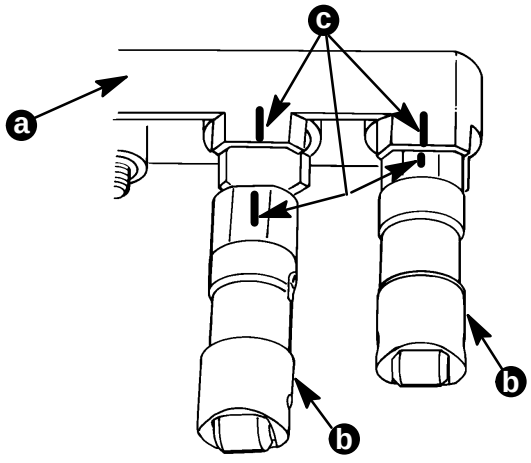
2. Remove fasteners from lifter retainers (restrictors) and remove retainers. Do not disturb lifters at this time.



71852

a - Lifter Retainer (Restrictor)
b - Fasteners

3. Make matching marks on all retainers and lifters as to location and orientation in bores, to allow reassembly in exact position on camshaft lobes (so that the roller’s bearing and roller will roll in the same direction on the same lobe, if reused). Remove valve lifters.



71853

a - Roller Lifter Retainer
b - Roller Lifter(s)
c - Matching Marks

Cleaning and Inspection

1. Thoroughly clean all parts in cleaning solvent and inspect them carefully.
2. If any parts are damaged or worn, entire lifter assembly should be replaced.
3. If outer lifter body wall is scuffed or worn, inspect cylinder block lifter bore.
4. If roller is worn or damaged, inspect camshaft lobe.
5. If push rod seat is scuffed or worn, inspect push rod.

Installation

IMPORTANT: It is recommended that the engine oil be changed and a new oil filter be installed whenever servicing valve lifters or camshaft.

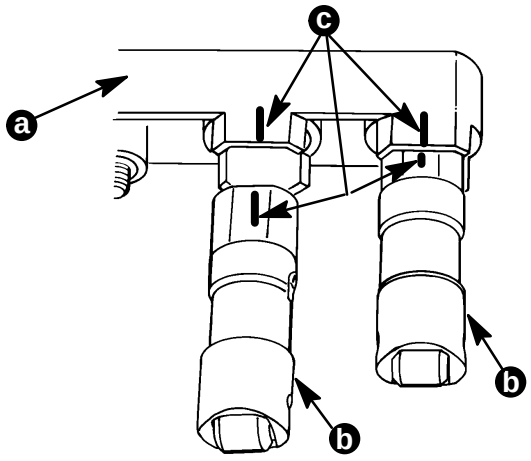
IMPORTANT: Before installing roller lifters, coat the roller with engine oil. If new lifters or a new camshaft have been installed, an additive containing EP lube (such as General Motors Cam and Lifter Prelube or equivalent) should be poured over camshaft lobes before installing lifters.

IMPORTANT: Before installation, coat entire valve lifter with engine oil.

IMPORTANT: DO NOT install used valve lifters if a new camshaft has been installed.

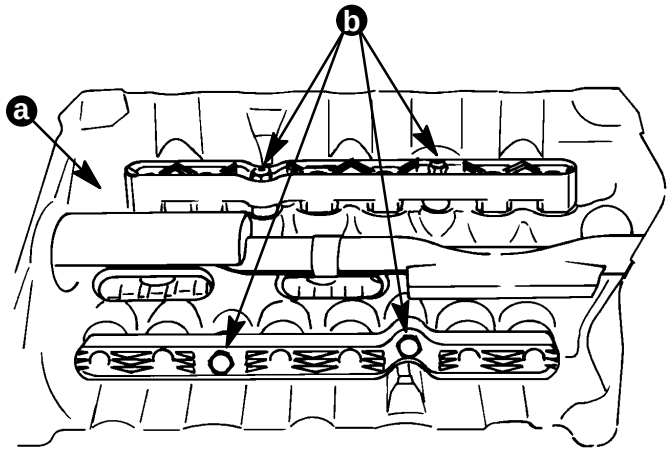
6. Align match marks made prior to disassembly, and install hydraulic valve lifters and components. Torque roller lifter retainer (restrictor) plate fasteners to 12 lb. ft. (16 N·m).

NOTE: *Components shown removed in upper drawing for visual clarity*



71853

a - Roller Lifter Retainer
b - Roller Lifter(s)
c - Matching Marks



71852

a - Lifter Retainer (Restrictor)
b - Fasteners

7. Install the following as previously outlined:
   a. Intake manifold.
   b. Install push rods. Be sure push rods seat in lifter socket.
   c. Install rocker arms and rocker arm nuts. Torque nuts to 20 lb. ft. (27 N·m).
   d. Install rocker arm cover. Torque fasteners to 50 lb. in. (5.5 N·m).
8. Start engine and check for leaks.

Valve Stem Oil Seal/Valve Spring

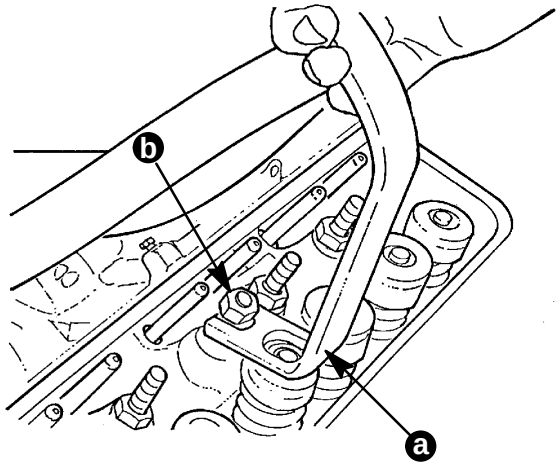
Removal - Head Installed

1. Remove:
   a. Rocker arm cover.
   b. Spark plug of affected cylinder.
   c. Rocker arm assembly.
2. Install air line adaptor tool (J-23590) in spark plug hole and apply compressed air to hold valves in place.

NOTE: *If compressed air is not available, piston may be brought up to TDC and used to keep valves from falling out of valve guides.*

IMPORTANT: Do not turn crankshaft while valve springs, retainers, and locks are removed or valves will fall into cylinder.

3. Using valve spring compressor as shown, compress valve spring and remove valve locks.



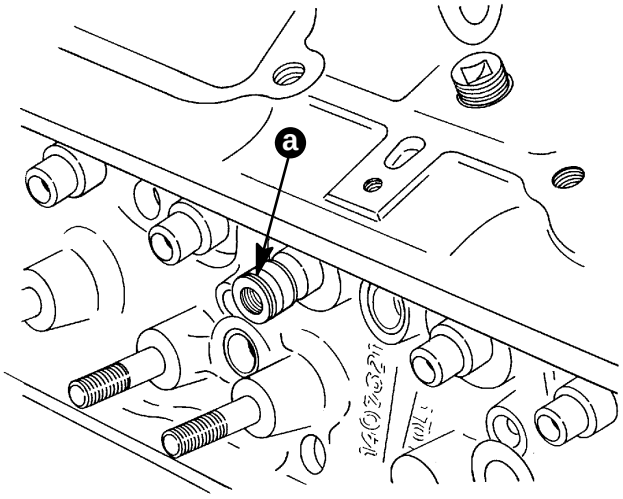
72881

a - Valve Spring Compressor (J-5892)
b - Rocker Arm Nut

4. Slowly release valve spring compressor. Remove cap, retainer or rotator, and valve spring.

IMPORTANT: Keep air pressure in cylinder while springs, caps, and valve locks are removed or valves will fall into cylinder.

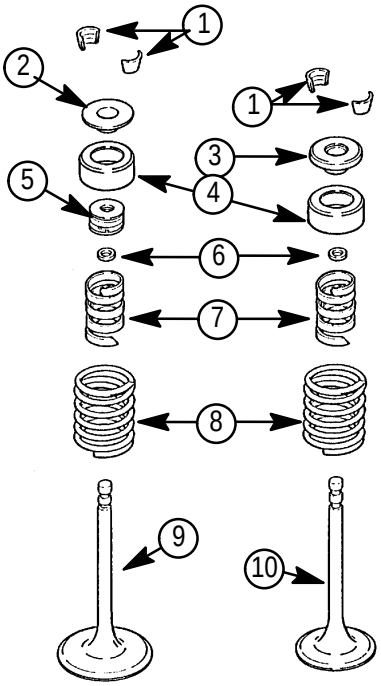
5. Remove seals from valve stems and valve guide.



72330

a - Valve Guide Seal

Valve Assembly (Exploded View)

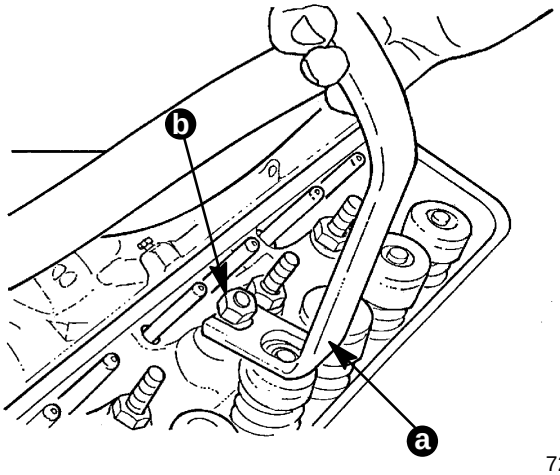


72882

1 - Valve Locks
2 - Retainer
3 - Rotator
4 - Cap
5 - Valve Guide Oil Seal
6 - Valve Stem Oil Seal
7 - Damper
8 - Outer Spring
9 - Intake Valve
10- Exhaust Valve

Installation - Head Installed

1. Install valve guide seal (intake valve only) over valve stem and push down until seated against head.
2. Set valve spring (with damper installed) and cap in place.
3. Place retainer on intake valve and/or rotator on exhaust valve.
4. While compressing valve spring with valve spring compressor, install oil seal in lower groove of valve stem, making sure seal is not twisted. A light coating of oil will help prevent twisting.
5. Install valve locks (Quicksilver Needle Bearing Assembly Lubricant may be used to hold them in place) and slowly release tool, making sure locks seat properly in upper grooves of valve stem.



72881

a - Valve Spring Compressor (J-5892)
b - Rocker Arm Nut

6. Install push rods and rocker arm assemblies.
7. Torque rocker arm nuts to 20 lb. ft. (27 N·m).
8. Install rocker arm cover [torque to 50 lb. in. (5.5 N·m)] and spark plug [torque to 15 lb. ft. (20 N·m)].

Cylinder Head

Removal

1. Drain engine cooling system.
2. Remove as outlined:
   a. Exhaust manifolds.
   b. Intake manifold.
   c. Rocker arm covers.
   d. Rocker arm assemblies and push rods (keep in order for reassembly in their original locations).
   e. Any components attached to front or rear of cylinder head.
   f. Spark plugs.
   g. Head bolts.

⚠CAUTION

The head gasket may be holding cylinder head to block. Use care when prying off cylinder heads. DO NOT damage gasket surfaces. DO NOT drop cylinder heads.

3. Place cylinder head on wooden blocks to prevent damage to gasket surfaces.

Cleaning and Inspection

1. Clean gasket material and sealer from engine block and cylinder heads.
2. Inspect sealing surfaces for deep nicks and scratches.
3. Inspect for corrosion around cooling passages.
4. Clean head bolt threads and engine block bolt hole threads, making sure no dirt, old oil or coolant remain.

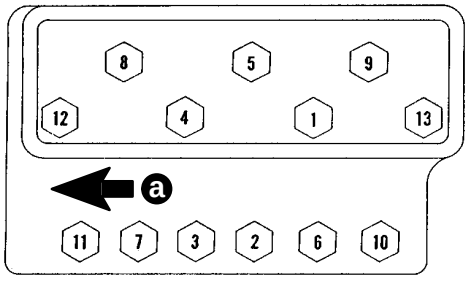
Installation

⚠CAUTION

When using ribbed stainless steel head gaskets, apply a thin coating of Quicksilver Perfect Seal to both sides of gasket. Too much sealer may hold gasket away from head or block causing leakage. DO NOT use sealer on graphite composition head gaskets.

1. Place head gasket in position over dowel pins.
2. Carefully set cylinder head in place over dowel pins.
3. Coat threads of head bolts with Quicksilver Perfect Seal and install finger-tight.
4. To insure gasket sealing:
   a. **All Engines (Except Gen +)**: Torque head bolts in three steps, following torque sequence for each step. Start first step at 20 lb. ft. (27 N·m), second step at 40 lb. ft. (54 N·m), and finish with a final torque of 65 lb. ft. (88 N·m).
   b. **Gen +**: Torque first pass to 22 lb. ft. (33 N·m). Second Pass (Angle Torque)

Short Bolt	55 Degrees
Medium Bolt	65 Degrees
Long Bolts	75 Degrees



72883

Cylinder Head Torque Sequence

a - Front

5. Install push rods, rocker arm assemblies and lifter restrictors in their original positions.
6. Torque rocker arm nuts to 20 lb. ft. (27 N·m).
7. Install as outlined:
   a. Intake manifold.
   b. Rocker arm covers.
   c. Exhaust manifolds.
   d. Spark plugs.
   e. Any components removed from front or rear of cylinder heads.
8. Follow procedures in Section 6A or 6B of this manual:

   Seawater Cooled Models: Provide for adequate water supply to seawater pickup (see Section 6A).

   Closed Cooled Models: Refill closed cooling section (see Section 6B), and provide adequate water supply to seawater pickup.

⚠CAUTION

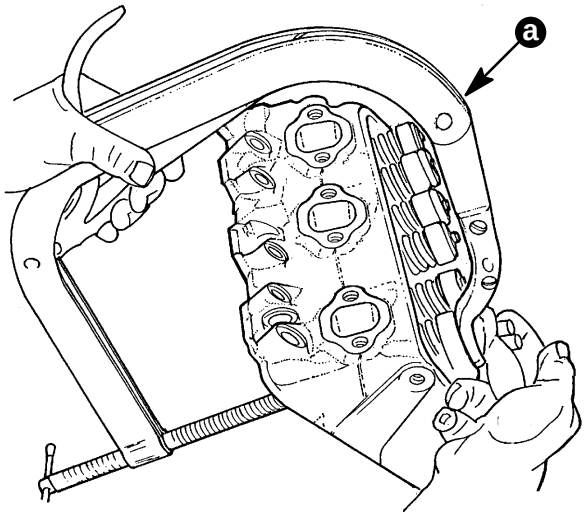
Ensure that cooling water supply is available before starting the engine.

9. Start engine, set timing, set idle speed, and check for leaks.

Cylinder Head and Valve Conditioning

Disassembly

1. Using valve spring compressor, compress valve spring and remove valve locks. Slowly release tool.



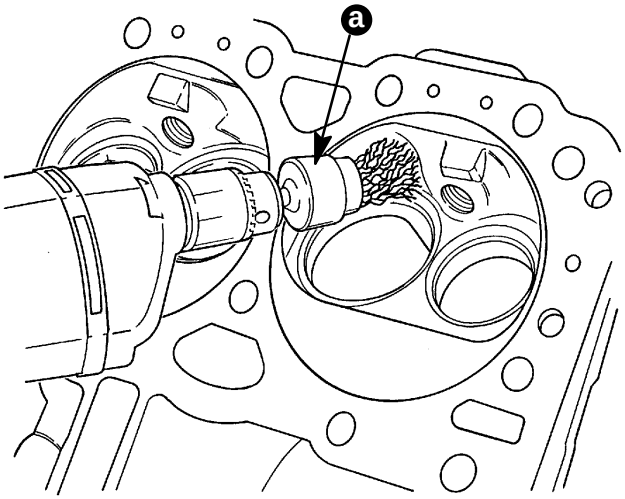
72884

a - Valve Spring Compressor (J-8062)

2. Remove all valve components.
3. Remove valves from cylinder head and place in a rack, in order, for reassembly in their original locations.

Cleaning

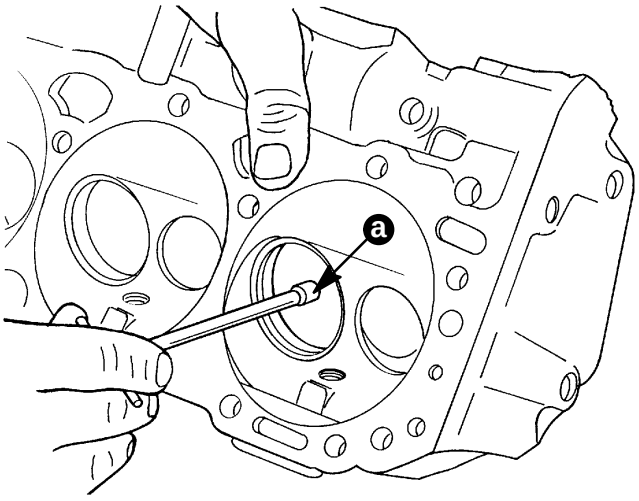
1. Clean push rods and rocker arm assemblies.
2. Clean carbon from valves using a wire wheel.
3. Clean gasket material from cylinder head mating surfaces.
4. Clean all carbon from combustion chambers and valve ports using carbon remover brush.



72334

a - Carbon Remover Brush (J-8089)

5. Thoroughly clean valve guides with valve guide cleaner.

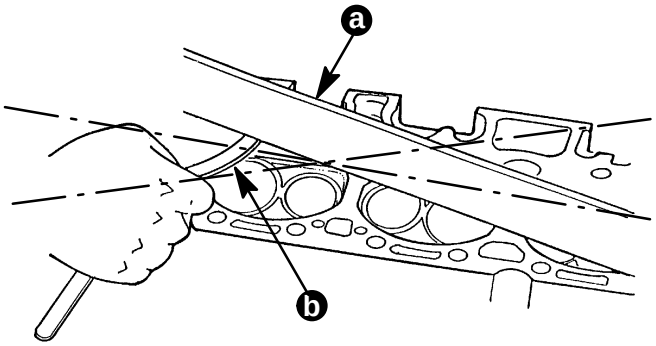


72335

a - Valve Guide Cleaner (J-8101)

Inspection

1. Inspect cylinder heads for cracks in exhaust ports, water jackets, and combustion chambers (especially around spark plug holes and valve seats). Replace heads if any cracks are found.
2. Inspect cylinder head gasket surface for burrs, nicks, or erosion or other damage. Also, check flatness of cylinder head gasket surface, using a machinist's straight edge and feeler gauges as shown. Refer to "Specifications."



72885

a - Straight Edge
b - Feeler Gauge
c - Take Measurements Diagonally Across Head (Both Ways) and Straight Down Center Head

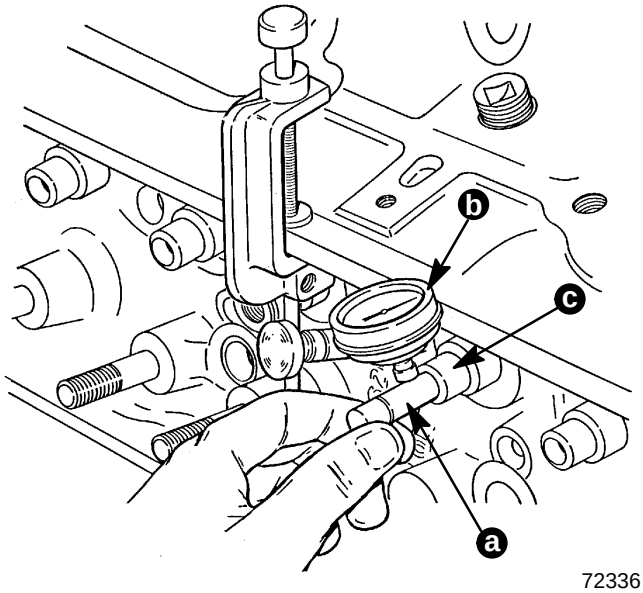
IMPORTANT: Cylinder head-to-block gasket surface should be resurfaced if warped more than specified. When head resurfacing is required, cylinder head-to-intake manifold gasket surface on head must be milled to provide proper alignment between intake manifold and head.

3. Inspect valves for burned heads, cracked faces or damaged stems.

IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and possible valve breakage. Insufficient clearance will result in noisy and sticky valves.

4. Measure valve stem clearance as follows:
   a. Attach a dial indicator to cylinder head, positioning it against the valve stem and close to the valve guide.
   b. Holding valve head off seat about 1/16 in. (2 mm), move valve stem back and forth in direction shown. Compare stem clearance with specifications.

c. If clearance exceeds specifications, it will be necessary to ream valve guides for oversized valves, as outlined under “Valve Guide Bore Repair.”



72336

a - Valve Stem
b - Dial Indicator
c - Valve Guide

Valve Guide Bore Repair

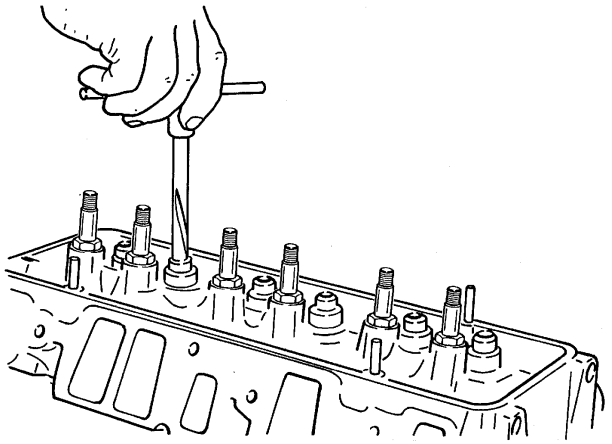
IMPORTANT: Be sure to measure valve stem diameter of both the intake and exhaust valve, as valve stem diameter may or may not be the same for both valves.

If .015 in. oversize valves are required, ream valve guide bores for oversize valves, as follows:

1. Measure valve stem diameter of old valve being replaced and select proper size valve guide reamer from chart below.

Standard Valve Stem Diameter	Reamer Required for .015 In. Oversize Valve
.341 In	J-5830-2
.372 In	J-7049

2. Ream valve guide bores, as shown.



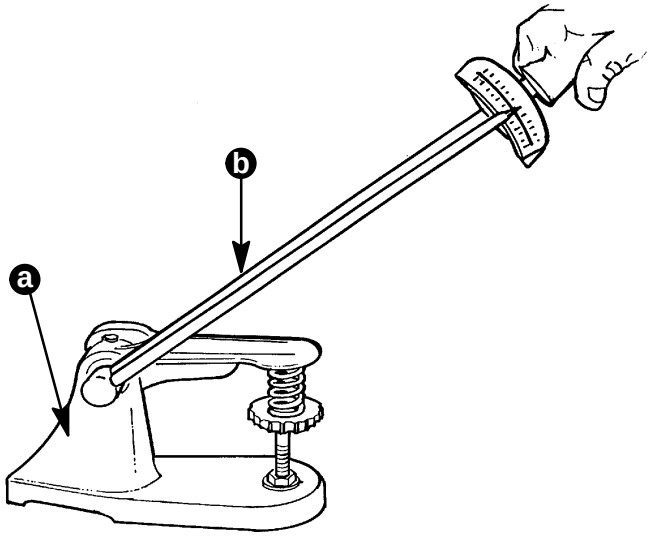
72886

3. Remove the sharp corner created by reamer at top of valve guide.

Valve Springs - Checking Tension

Using valve spring tester, as shown, check valve spring tension with dampers removed. Refer to “Specifications.”

IMPORTANT: Springs should be replaced if not within 10 lbs. (44 N) of specified tension.



72308

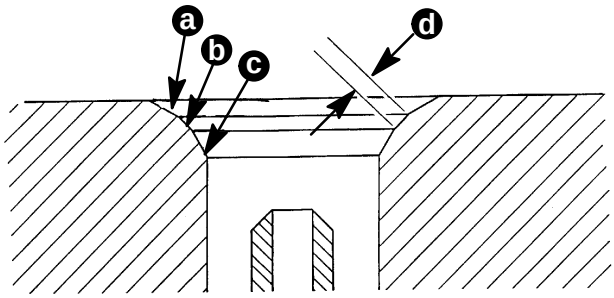
a - Valve Spring Tester (J-8056)
b - Torque Wrench

Valve Seat Repair

Valve seat reconditioning is very important, since seating of valves must be perfect for engine to deliver maximum power and performance.

Another important factor is valve head cooling. Good contact between each valve and its seat in head is important to ensure that heat in valve head will be properly dispersed.

Several different types of equipment are available for reseating valve seats. Equipment manufacturer's recommendations should be followed carefully to attain proper results.

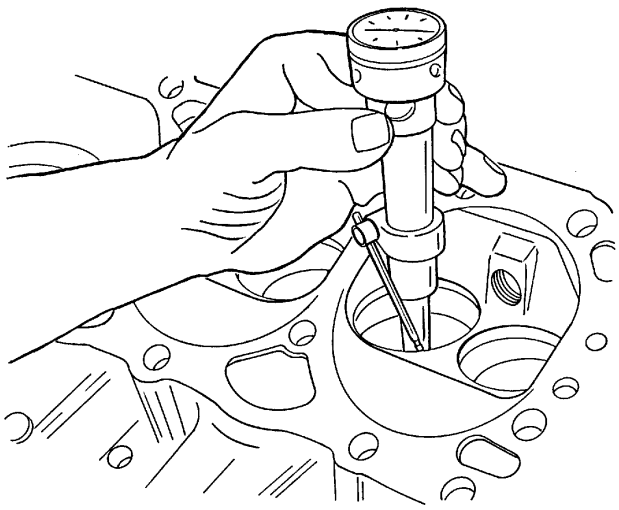


50668

Typical "3-Angle" Valve Seat

a - Top Angle (30°)
b - Seat Angle (46°)
c - Bottom Angle (60°)
d - Seat Width

Regardless of type of equipment, however, it is essential that valve guide bores be free from carbon or dirt to achieve proper centering of pilot in valve guide, ensuring concentricity.



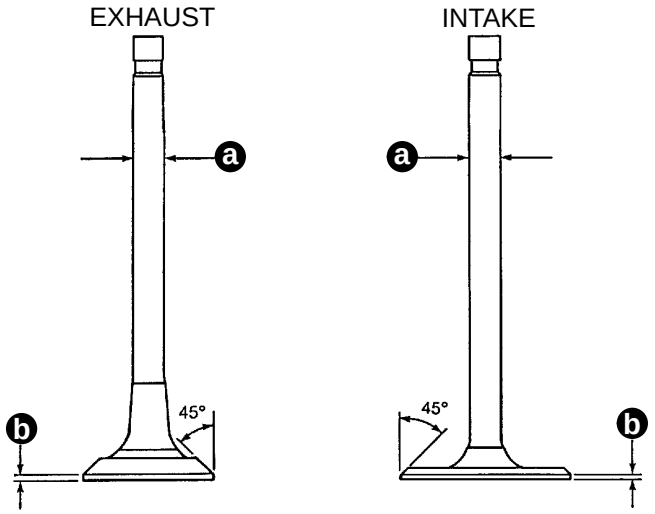
72338

Measuring Valve Seat Concentricity

Valve Grinding

Valves that are pitted must be refaced to the proper angle. Valve stems which show excessive wear, or valves that are warped excessively, must be replaced. When a valve head which is warped excessively is refaced, a knife edge will be ground on part or all of the valve head, due to the amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning, or pre-ignition due to heat localizing on this knife edge. If the edge of the valve head is less than 1/32 in. (0.8 mm) after grinding, replace the valve.

Several different types of equipment are available for refacing valves. The recommendation of the manufacturer of the equipment being used should be carefully followed to attain proper results.



50695

Exhaust

a - .372 In (9.45 mm)
b - 1/32 [.031] In (0.79 mm) Min

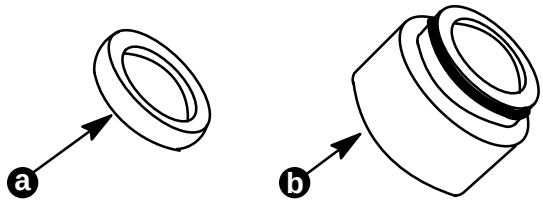
Intake

a - .341 In (8.16 mm)
b - 1/32 [.031] In (0.79 mm) Min

Reassembly

1. Lubricate valve guides and valve stems with engine oil.
2. Install each valve in the port from which it was removed or to which it was fitted.
3. Install valve guide seal (intake valve only) over valve stem and push down until seated against head.

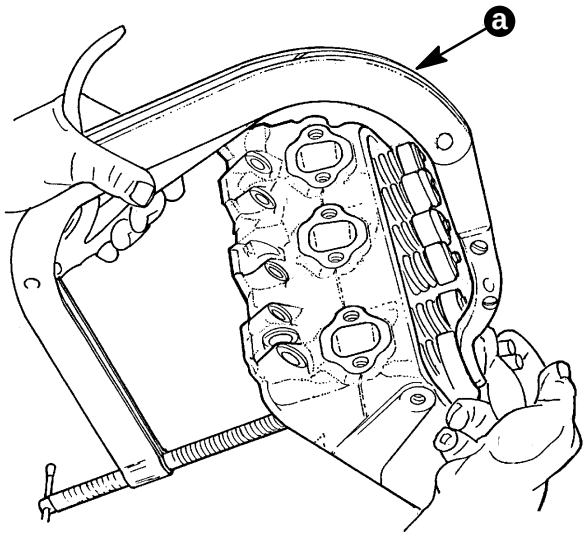
IMPORTANT: Some Gen+ engines that have the exhaust valve guide seals removed. It is replaced with a quad ring as shown below. If repairing heads with seals, replace them with the quad ring upon reassembly.



75307

a - Quad Ring
b - Valve Seal

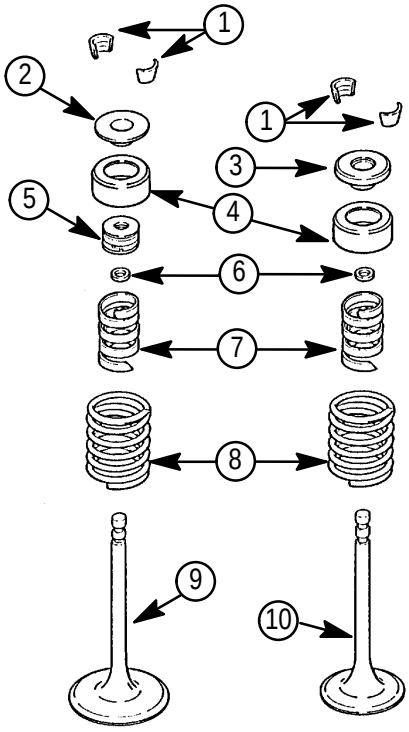
4. Set valve spring (with damper installed) and cap in place.
5. Place retainer on intake valve and/or rotator on exhaust valve.
6. While compressing valve spring with valve spring compressor, install oil seal in lower groove of valve stem, making sure seal is not twisted. A light coating of oil will help prevent twisting.



72884

a - Valve Spring Compressor (J-8062)

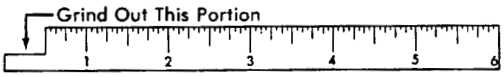
7. Install valve locks (grease may be used to hold them in place) and slowly release tool, making sure locks seat properly in upper grooves of valve stem.



72882

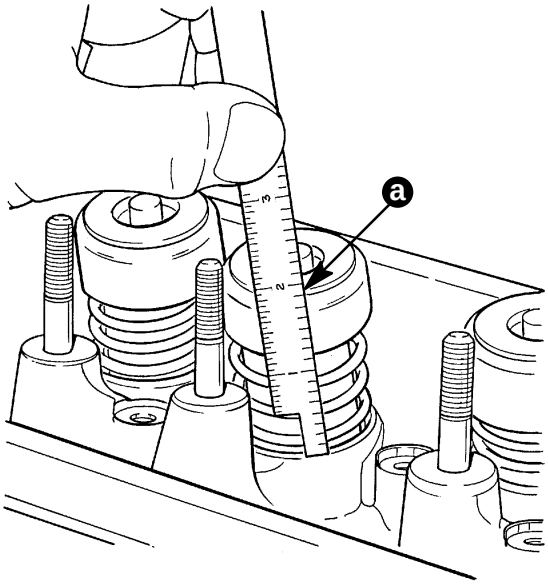
1 - Valve Locks
2 - Retainer
3 - Rotator
4 - Cap
5 - Valve Guide Oil Seal
6 - Valve Stem Oil Seal (See Important)
7 - Damper
8 - Outer Spring
9 - Intake Valve
10- Exhaust Valve

8. Check installed height of valve springs using a narrow, thin scale. Measure from spring seat to top of valve spring, as shown. If measurement exceeds specified height, install a valve spring shim and recheck. DO NOT shim valve springs to give an installed height less than the minimum specified.



05037

Cutaway Scale



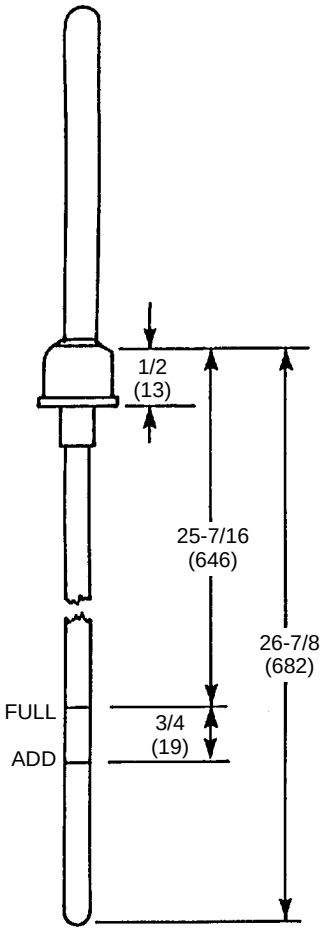
72339

a - Valve Spring Installed Height

Dipstick Specifications

All Engines

UNIT OF MEASUREMENT In. (mm)



41092-1
MCM

72887

Oil Pan

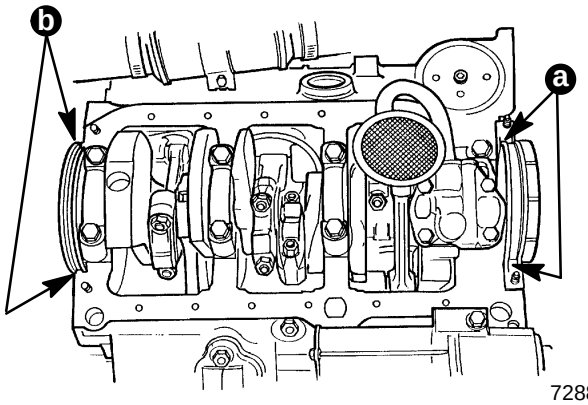
Removal

1. Drain crankcase oil.
2. Remove dipstick and tube.
3. Remove oil pan.

Installation

1. Clean sealing surfaces of engine block and oil pan.
2. Apply a small amount of Quicksilver RTV Sealer to joints of rear seal retainer and joints of front cover.

IMPORTANT: Quicksilver RTV Sealer sets up in about 15 minutes. Be sure to complete assembly promptly.

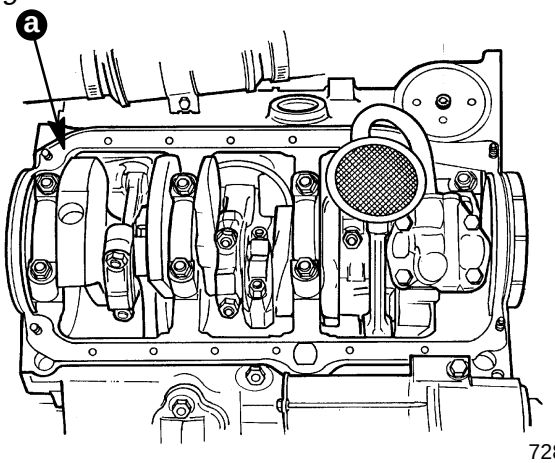


72888

a - Joints of Rear Seal Retainer
b - Joints of Front Cover

3. Install oil pan gasket in position as shown.

NOTE: *A one-piece oil pan gasket may be reused if it is still pliable and is not cracked, torn or otherwise damaged.*

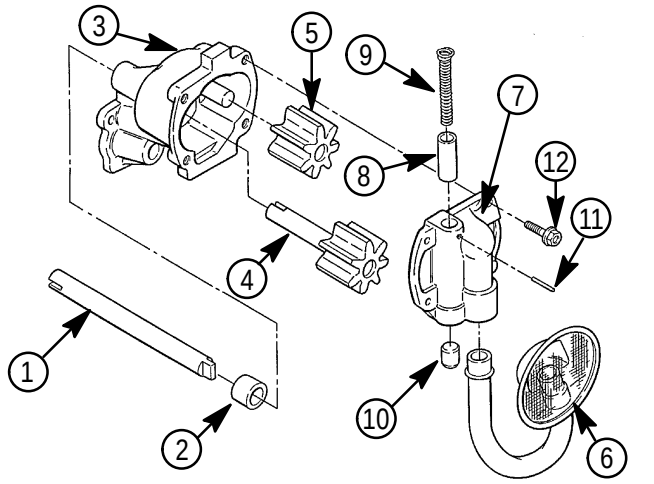


72889

a - Oil Pan Gasket

4. Install oil pan. Starting from the center and working outward in each direction, tighten 1/4-20 threaded fasteners to 80 lb. in. (9 N·m) and 5/16-18 threaded fasteners to 165 lb. in. (19 N·m). **Gen +** engines torque to nuts and bolts to 18 lb. ft. (25 N·m).
5. Install dipstick tube and dipstick.
6. Fill crankcase with required quantity of oil of specified viscosity. See Section 1B - “Maintenance.”

Oil Pump



72145

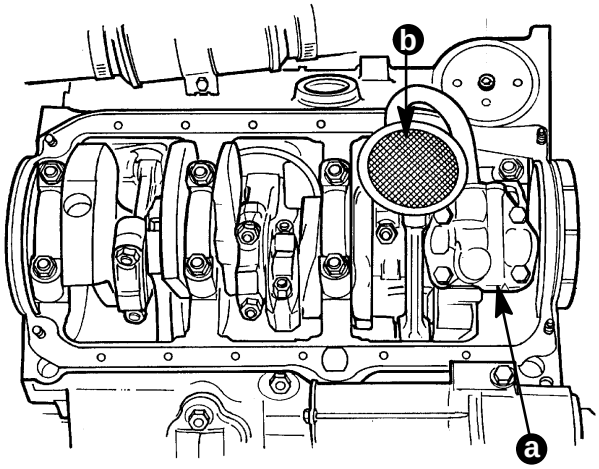
Oil Pump Assembly

1 - Extension Shaft
2 - Shaft Coupling
3 - Pump Body
4 - Drive Gear and Shaft
5 - Idler Gear
6 - Pickup Screen and Pipe
7 - Pump Cover
8 - Pressure Regulator Valve
9 - Pressure Regulator Spring
10- Plug
11- Retaining Pin
12- Screws

The oil pump consists of two gears and a pressure regulator valve enclosed in a two-piece housing. Oil pump is driven by distributor shaft which is driven by a helical gear on camshaft.

Removal

1. Remove oil pan as previously outlined.
2. Remove gasket carefully as the one-piece gasket for the oil pan may be reused if still pliable and not cracked, torn, etc.



72889

a - Oil Pump
b - Pickup Screen and Pipe

3. Remove oil pump

Disassembly

1. Remove pump cover.

IMPORTANT: Mark gear teeth for reassembly with same teeth indexing.

2. Remove idler gear and drive gear from pump body.
3. Remove retaining pin, spring, and pressure regulator valve from pump cover.

IMPORTANT: Do not remove pickup screen and pipe assembly, unless replacement is necessary. Loss of press fit condition could result in an air leak and loss of oil pressure.

IMPORTANT: Do not disturb pickup screen on pipe. This is serviced as an assembly.

4. If pickup screen and pipe assembly requires replacement, mount pump in a soft-jawed vise and extract pipe from pump.

Cleaning and Inspection

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage and excessive wear.
4. Check for loose drive gear shaft in pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.
6. Inspect pickup screen and pipe assembly for damage to screen and pipe.
7. Check pressure regulator valve for fit.

IMPORTANT: Pump gears and body are not serviced separately. If pump gears or body are damaged or worn, replacement of entire oil pump assembly is necessary.

Reassembly

⚠CAUTION

Be careful of twisting, shearing or collapsing pipe while installing in pump. Pickup screen must be parallel to oil pan bottom when oil pump is installed.

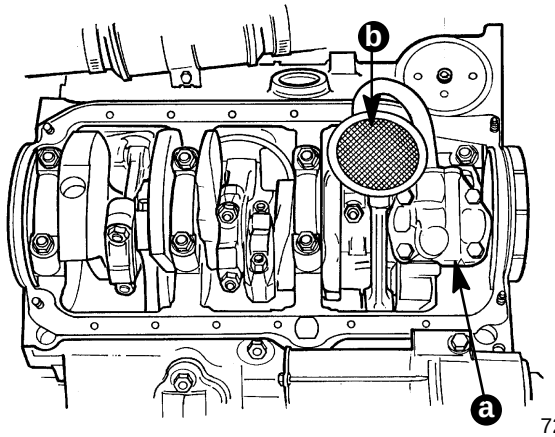
If pickup screen and pipe assembly was removed, mount pump in a soft-jawed vise, apply Quicksilver Perfect Seal to end of new pipe and, using oil pump suction pipe installer (J-21882), tap the pipe in place with a hammer.

IMPORTANT: Oil internal parts liberally before installation.

1. Install pressure regulator valve and related parts.
2. Install drive gear in pump body.
3. Install idler gear in pump body with smooth side of gear toward pump cover opening. Align marks made in disassembly.
4. Fill gear cavity with engine oil.
5. Install pump cover and torque attaching bolts to 80 lb. in. (9 N·m). **Gen +** 106 lb. in. (12 N·m).
6. Turn extension shaft by hand to check for smooth operation.

Installation

1. Install pump, with extension shaft, to rear main bearing, aligning extension shaft with distributor drive shaft.
2. Tighten oil pump bolt to 65 lb. ft. (88 N·m).



72889

a - Oil Pump
b - Pickup Screen and Pipe

3. Install oil pan as outlined. The one-piece gasket for the oil pan may be reused if still pliable and not cracked, torn, etc.

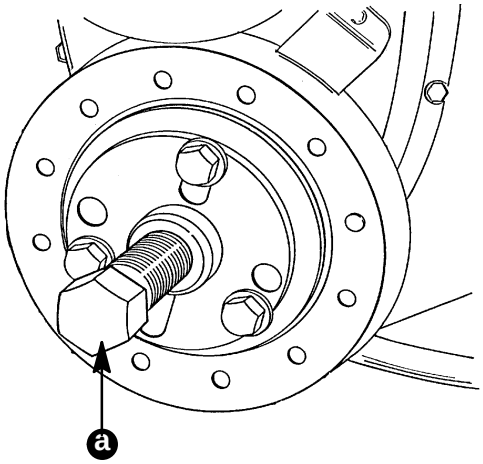
Torsional Damper

Removal

1. Remove drive belts.
2. Remove drive pulley, then remove torsional damper retaining bolt.

IMPORTANT: Do not use a universal claw type puller to remove torsional damper (in next step) as outside ring of torsional damper is bonded in rubber to the hub and use of claw type puller may break the bond.

3. Remove torsional damper with torsional damper remover and installer.



72890

a - Torsional Damper Remover and Installer (J-23523-E)

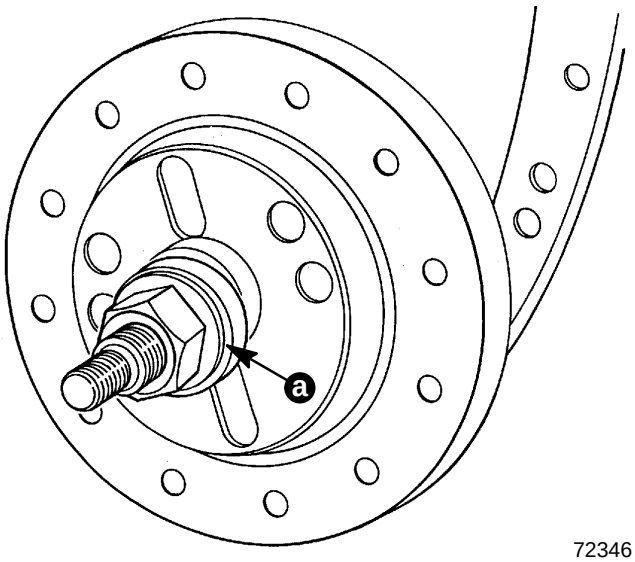
Installation

IMPORTANT: The inertia weight section of torsional damper is assembled to the hub with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight on the hub will destroy the tuning of the torsional damper.

1. Replace key in crankshaft if it is damaged.
2. Coat seal surface of torsional damper with engine oil.
3. Install torsional damper on crankshaft, using torsional damper remover and installer as follows:
   a. Install appropriate end of threaded rod into crankshaft.

IMPORTANT: Be sure to install threaded rod in crankshaft at least 1/2 in. (13 mm) to prevent damage to threads.

   b. Install plate, thrust bearing, washer and nut on rod.
   c. Install torsional damper on crankshaft by turning nut until it bottoms out.



72346

a - Torsional Damper Remover and Installer (J-23523-E)

   d. Remove tool from crankshaft.
   e. To prevent oil leakage, apply Quicksilver RTV sealant to torsional damper keyway.
   f. Install torsional damper bolt. Torque to 70 lb. ft. (95 N·m). **Gen +** 74 lb. ft. (100 N·m).
4. Install drive pulley(s). Torque bolts to 35 lb. ft. (48 N·m).
5. Install and adjust drive belts.

Crankcase Front Cover/Oil Seal

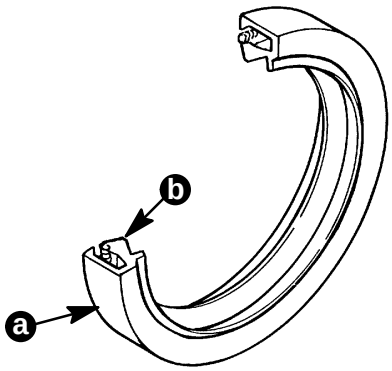
Oil Seal Replacement (Without Removing Front Cover)

REMOVAL

1. Remove torsional damper.
2. Pry seal out of cover from the front with a large screwdriver, being careful not to distort front cover or damage crankshaft.

INSTALLATION

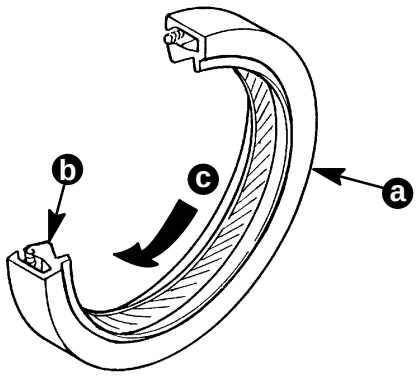
IMPORTANT: Correct rotation oil seal must be used to prevent oil leak.



73123

Front Seal WITHOUT Helical Grooves

a - Can Be Used on Any Rotation Engine
b - Seal Lip Toward Inside of Engine

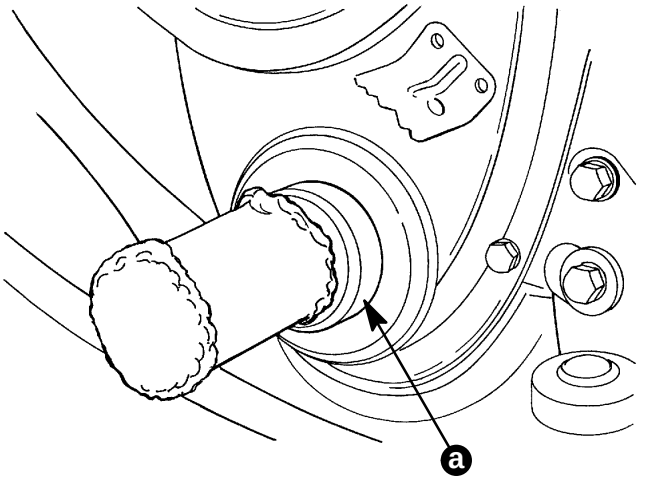


73124

Front Seals WITH Helical Grooves

a - MCM (LH) Rotation Engines
b - Seal Lip Toward Inside of Engine
c - Rotation of Crankshaft as Viewed from Front End Looking Toward Flywheel End

1. Apply Quicksilver Perfect Seal to seal retainer mating surface and apply grease to seal lips.
2. Install new seal with open end of seal inward, using crankcase front cover seal installer. Drive seal in until it just bottoms out. Do not use excessive force.



72347

a - Crankcase Front Cover Seal Installer (J-35468)

3. Reinstall torsional damper as outlined.

Crankcase Front Cover

Removal

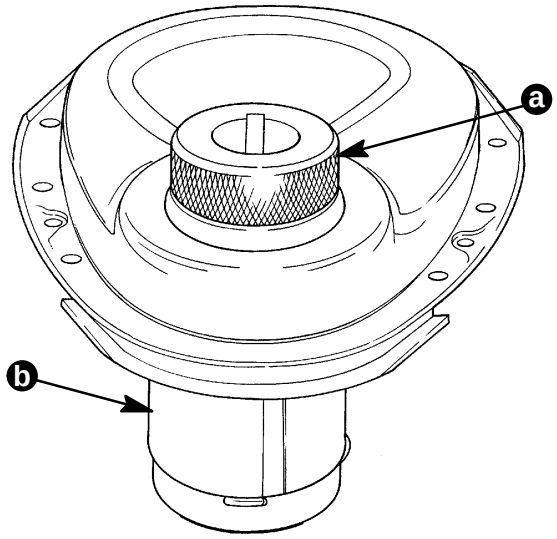
1. Remove engine from boat if necessary to gain access to cover.
2. Remove torsional damper and oil pan.
3. Remove water circulating pump.
4. Remove crankcase front cover.
5. If damaged, drive oil seal out of front cover (from the rear) using a punch.

Cleaning and Inspection

Clean front cover in solvent and dry with compressed air. Clean old gasket material and sealer from mating surfaces on cover and cylinder block. Check gasket surface on front cover for distortion, and true if necessary. Surfaces must be clean and flat or oil leakage may result.

Installation

1. Install oil seal in cover with lip of seal toward inside of engine, using crankcase front cover seal installer. Support cover around seal area with appropriate tool as shown.



72348

a - Crankcase Front Cover Seal Installer (J-35468).
b - Support (to Prevent Distorting Cover)

2. Coat both sides of front cover gasket with Quicksilver Perfect Seal and place in position on engine.
3. Install front cover, making sure holes in cover align with dowel pins in block. Torque front cover attaching screws to 100 lb. in. (11 N·m).
4. Install oil pan and torsional damper as outlined.
5. Install water circulating pump.
6. Reinstall engine in boat.
7. Fill crankcase with engine oil.
8. Follow procedures in Section 6A or 6B of this manual:

Seawater Cooled Models: Provide for adequate water supply to seawater pickup (see Section 6A).

Closed Cooled Models: Refill closed cooling section (see Section 6B), and provide adequate water supply to seawater pickup.

⚠CAUTION

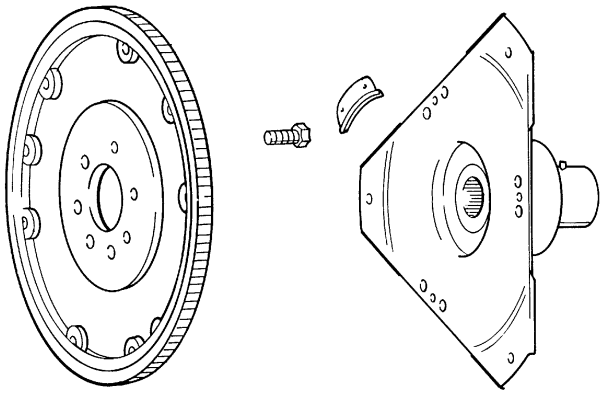
Ensure that cooling water supply is available before starting the engine.

9. Start engine and check for water and oil leaks.

Flywheel

Removal

1. Remove engine from boat. Refer to SECTION 2 - “Removal and Installation”.
2. Refer to “Flywheel Housing” description in this section and remove flywheel housing and related parts.
3. Remove coupler.
4. Remove flywheel.



72349

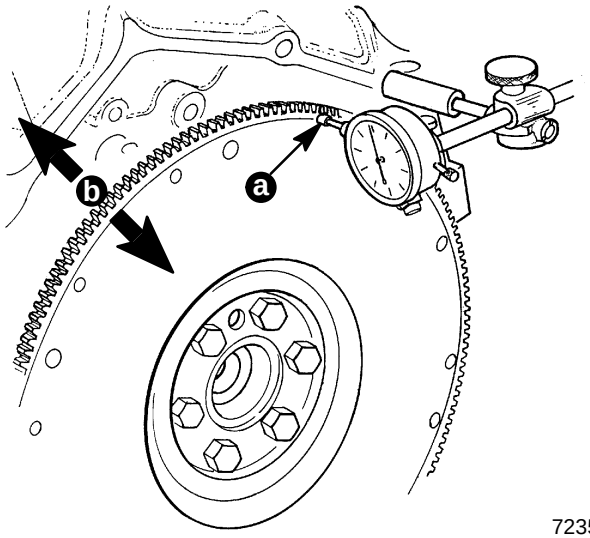
Alpha One Coupler

Inspection

1. Inspect splines in coupler for wear.
2. Check flywheel ring gear for worn and missing teeth.

Installation

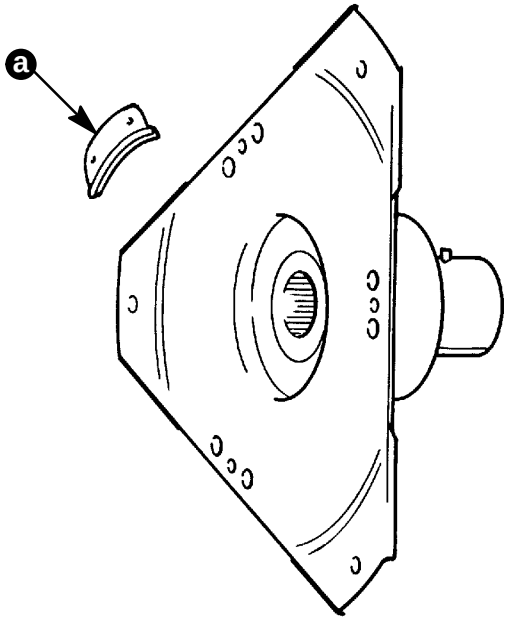
1. Clean mating surfaces of flywheel and crankshaft. Remove any burrs. Mating surfaces must be clean bare metal.
2. Aligning dowel hole in flywheel with dowel in crankshaft, install flywheel. Torque bolts to 75 lb. ft. (100 N·m).
3. Check flywheel runout as follows:
   a. Attach a dial indicator to engine block.
   b. Take readings around outer edge of flywheel. Push in on flywheel to remove crankshaft end play.
   c. Maximum runout - .008 in. (0.203 mm).



72353

a - .008 In. (0.203 mm) Max Runout
b - Push Flywheel and Crankshaft Froward as Far as it will Go when Taking Reading

IMPORTANT: Insert three rubber bumpers in Alpha coupler before installation on flywheel.



72354

a - Rubber Bumper

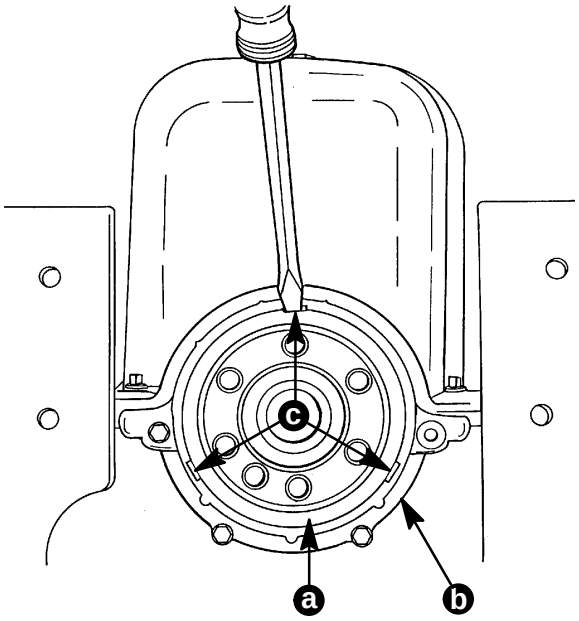
4. Install drive coupler. Torque bolts to 35 lb. ft. (48 N·m).
5. Install flywheel housing and related parts. Torque bolts to 30 lb. ft. (41 N·m).
6. Install flywheel housing cover. Torque bolts to 80 lb. in. (9 N·m).
7. Refer to Section 2 “Removal and Installation” and install engine.

Rear Main Oil Seal

The rear crankshaft oil seal can be replaced without removing the oil pan or rear main bearing cap from engine.

Removal

Remove seal by using a screwdriver to pry it out of retainer as shown.



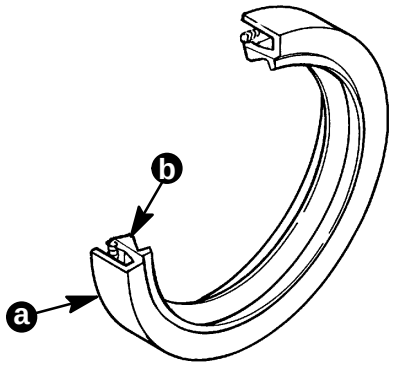
72355

a - Rear Seal
b - Seal Retainer
c - Slots (Three)

Cleaning and Inspection

Clean crankshaft/seal running surface and seal retainer.

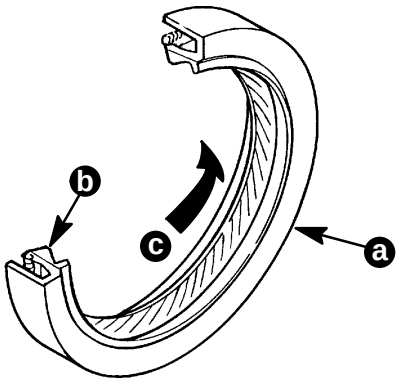
IMPORTANT: Correct rotation oil seal must be used to prevent oil leak.



73126

Rear Seal WITHOUT Helical Grooves

a - Can Be Used On Any Rotation Engine
b - Seal Lip Toward Inside Of Engine



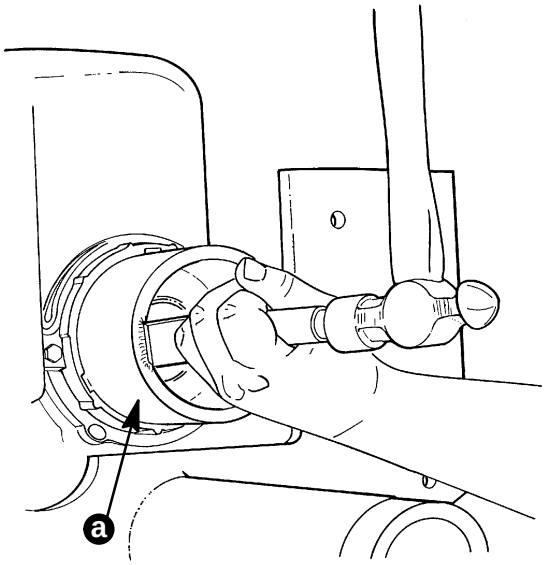
73127

Rear Seal WITH Helical Grooves

a - MCM (LH) Rotation Engines
b - Seal Lip Toward Inside Of Engine
c - Rotation Of Crankshaft As Viewed From Flywheel End Looking Forward

Installation

1. Apply Quicksilver Perfect Seal to seal retainer mating surface. Apply grease to seal lips.
2. Install seal using rear main seal installer.



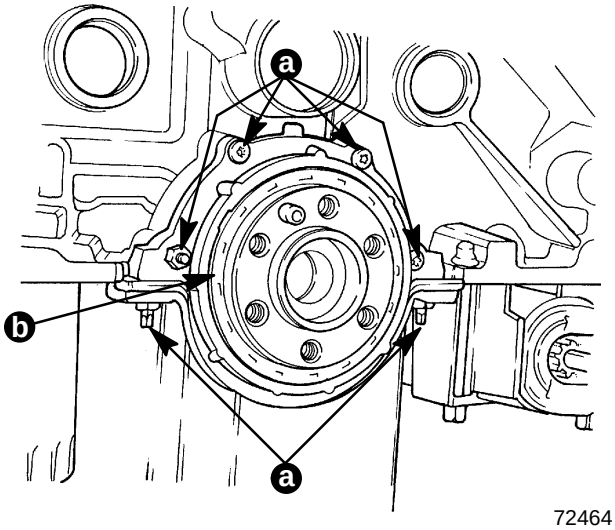
72356

a - Rear Main Seal Installer (J-26817-A)

Rear Main Oil Seal Retainer

Removal

1. Remove oil pan.
2. Remove oil seal retainer fasteners.
3. Remove oil seal retainer.



72464

a - Fasteners
b - Oil Seal Retainer

Cleaning and Inspection

1. Clean gasket material from mating surfaces.
2. Inspect oil seal retainer for cracks or scored surface.
3. Inspect oil seal for worn, dry or torn rubber. Replace if necessary (refer to “Rear Main Oil Seal” as outlined).
4. Inspect alignment pin for damage; replace if necessary.

Installation

1. Coat seal lips with clean 30W motor oil.
2. Install gasket and oil seal retainer with rear main seal.
3. Coat threads of oil seal retainer fasteners with Loctite Pipe Sealant with Teflon.
4. Install fasteners and torque to 133 lb. in. (15 N·m).
5. Install oil pan fasteners. Torque 1/4-20 threaded fasteners to 80 lb. in. (9 N·m) and 5/16-18 threaded fasteners to 165 lb. in. (19 N·m).Torque **Gen+** engine oil pan nuts and bolts 18 lb. ft. (25 N·m)

NOTE: *A one-piece oil pan gasket may be re-used if it is still pliable and is not cracked, torn or otherwise damaged.*

Main Bearings

IMPORTANT: Before removing main bearing caps or connecting rod caps, mark them for reassembly in their original locations.

Main bearings are of the precision insert type and do not use shims for adjustment. If clearances are found to be excessive, a new bearing, both upper and lower halves, will be required. Service bearings are available in standard size and .001 in., .010 in. and .020 in. undersize.

Selective fitting of both rod and main bearing inserts is necessary in production in order to obtain close tolerances. For this reason you may find one half of a standard insert with one half of a .001 in. undersize insert which will decrease the clearance .0005 in. from using a full standard bearing.

IMPORTANT: If crankshaft has an undersize journal and a new bearing is required, journal must be reconditioned to accept a .010 or .020 in. undersize bearing as .009 in. undersize bearings are not available for service.

Inspection

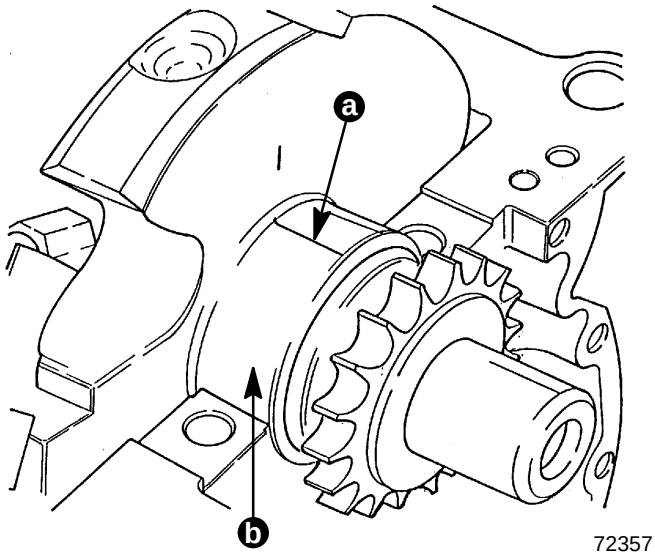
In general, the lower half of the bearing (except No. 1 bearing) shows a greater wear and the most distress from fatigue. If, upon inspection, the lower half is suitable for use, it can be assumed that the upper half is also satisfactory. If the lower half shows evidence of wear or damage, both upper and lower halves should be replaced. Never replace one half without replacing the other half.

Checking Clearances

To obtain accurate measurements while using Plastigage, or its equivalent, engine must be out of the boat and upside down so crankshaft will rest on the upper bearings and total clearance can be measured between lower bearing and journal.

To assure the proper seating of the crankshaft, all bearing cap bolts should be at their specified torque. In addition, preparatory to checking fit of bearings, the surface of the crankshaft journal and bearing should be wiped clean of oil.

1. With the oil pan and oil pump removed, remove bearing cap and wipe oil from journal and bearing cap to be inspected.
2. Place a piece of gauging plastic the full width of the bearing (parallel to the crankshaft) on the journal as shown.



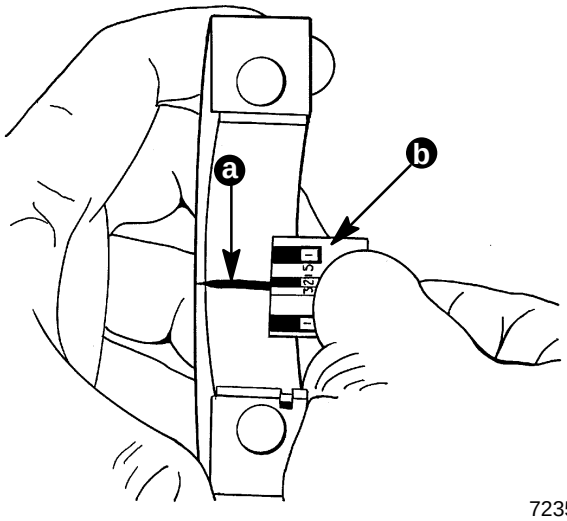
72357

a - Gauging Plastic
b - Journal

3. Install the bearing cap and evenly torque the retaining bolts to specifications. Bearing cap MUST be torqued to specification in order to assure proper reading. Variations in torque affect the compression of the plastic gauge.

IMPORTANT: Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.

4. Remove bearing cap. The flattened gauging plastic will be found adhering to either the bearing cap or journal.
5. On the edge of the gauging plastic envelope there is a graduated scale which is correlated in thousandths of an inch. Without removing the gauging plastic, measure its compressed width (at the widest point) with the graduations on the gauging plastic envelope as shown.

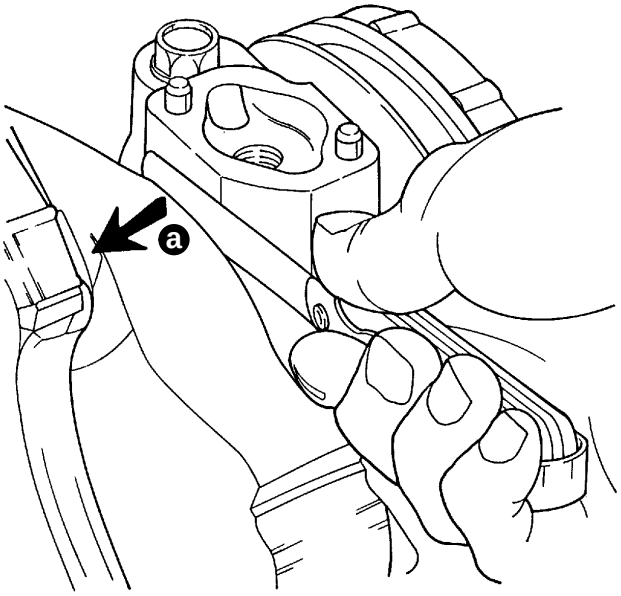


72358

a - Compressed Gauging Plastic
b - Graduated Scale

NOTE: *Normally main bearing journals wear evenly and are not out of round. However, if a bearing is being fitted to an out-of-round journal (.001 in. max.), be sure to fit to the maximum diameter of the journal: If the bearing is fitted to the minimum diameter, and the journal is out of round .001 in., interference between the bearing and journal will result in rapid bearing failure. If the flattened gauging plastic tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of the bearing or journal. Be sure to measure the journal with a micrometer if the flattened gauging plastic indicates more than .001 in. difference.*

6. If the bearing clearance is within specifications, the bearing insert is satisfactory. If the clearance is not within specifications, replace the insert. Always replace both upper and lower inserts as a unit.
7. A standard, or .001 in., undersize bearing may produce the proper clearance. If not, it will be necessary to regrind the crankshaft journal for use with the next undersize bearing.
   a. After selecting new bearing, recheck clearance.
8. Proceed to the next bearing. After all bearings have been checked, rotate the crankshaft to see that there is no excessive drag. When checking No. 1 main bearing, loosen accessory drive belts so as to prevent tapered reading with plastic gauge.
9. Measure crankshaft end play by forcing the crankshaft to the extreme front position. Measure at the front end of the rear main bearing with a feeler gauge as shown [Specifications - .002-.006 (0.051-0.152)].

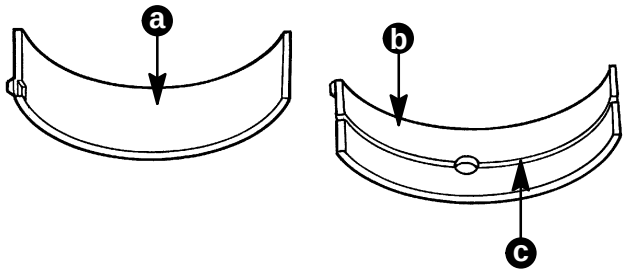


72360

a - Force Crankshaft to Extreme Forward Position

Replacement

NOTE: *Main bearings may be replaced with or without removing crankshaft.*



72359

Main Bearing Inserts

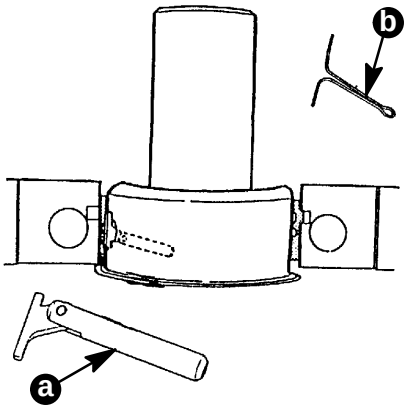
b - Lower Bearing Insert (Install in Cap)
c - Upper Bearing Insert (Install in Block)
d - Oil Groove

WITH CRANKSHAFT REMOVED

1. Remove and inspect the crankshaft as outlined.
2. Remove the main bearings from the cylinder block and main bearing caps.
3. Coat bearing surfaces of new, correct size, main bearings with oil and install in the cylinder block and main bearing caps.
4. Install the crankshaft.

WITHOUT CRANKSHAFT REMOVED

1. With oil pan, oil pump and spark plugs removed, remove cap on main bearing requiring replacement and remove bearing from cap.
2. Install main bearing remover/installer in oil hole in crankshaft journal. If such a tool is not available, a cotter pin may be bent, as shown, to do the job.



72622

a - Main Bearing Remover/Installer (J-8080)
b - Cotter Pin

3. Rotate the crankshaft clockwise as viewed from the front of engine. This will roll upper bearing out of block.
4. Oil new selected size upper bearing and insert plain (un-notched) end between crankshaft and indented or notched side of block. Rotate the bearing into place and remove tool from oil hole in crankshaft journal.
5. Oil new lower bearing and install in bearing cap.
6. Install main bearing cap with arrows pointing toward front of engine.
7. Torque all main bearing caps, EXCEPT THE REAR MAIN CAP, to 75 lb. ft. (102 N·m). Torque rear main bearing cap to 10-12 lb. ft. (14-16 N·m); then tap end of crankshaft, first rearward then forward with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces. Torque rear main bearing cap to 75 lb. ft. (102 N·m).

Connecting Rod Bearings

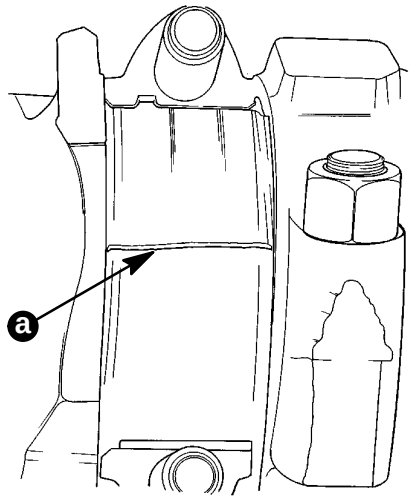
Connecting rod bearings are of the precision insert type and do not use shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive, a new bearing will be required. Service bearings are available in standard size and .001 in. and .002 in. undersize for use with new and used standard size crankshafts, and in .010 in. and .020 in. undersize for use with reconditioned crankshafts.

On removing a connecting rod cap, it is possible to find a .010 in. undersize bearing. These are used in manufacturing for selective fitting.

Inspection and Replacement

IMPORTANT: Before you remove the connecting rod cap, mark the side of the rod and cap with the cylinder number to assure matched reassembly of rod and cap.

1. With oil pan and oil pump removed, remove the connecting rod cap and bearing.
2. Inspect the bearing for evidence of wear and damage. Do not reinstall a worn or damaged bearing.
3. Wipe both upper and lower bearing shells and crankpin clean of oil.
4. Measure the crankpin for out-of-round or taper with a micrometer. If not within specifications, replace or recondition the crankshaft. If within specifications and a new bearing is to be installed, measure the maximum diameter of the crankpin to determine new bearing size required.
5. If within specifications, measure new or used bearing clearances with gauging plastic or its equivalent. If a bearing is being fitted to an out-of-round crankpin, be sure to fit to the maximum diameter of the crankpin. If the bearing is fitted to the minimum diameter, and the crankpin is out of round .001 in., interference between the bearing and crankpin will result in rapid bearing failure.
   a. Place a piece of gauging plastic, the length of the bearing (parallel to the crankshaft), on the crankpin or bearing surface as shown. Position the gauging plastic in the middle of the bearing shell. (Bearings are eccentric and false readings could occur if placed elsewhere.)



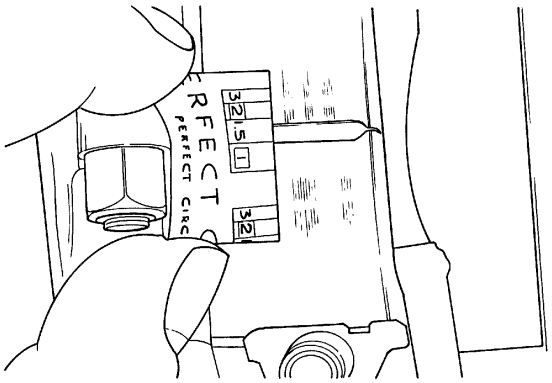
72361

a - Gauging Plastic

   b. Install the bearing in the connecting rod and cap.
   c. Install the bearing cap and evenly torque nuts to 45 lb. ft. (61 N·m).

IMPORTANT: Do not turn the crankshaft with the gauging plastic installed.

d. Remove the bearing cap and using the scale on the gauging plastic envelope, measure the gauging plastic width at the widest point as shown.

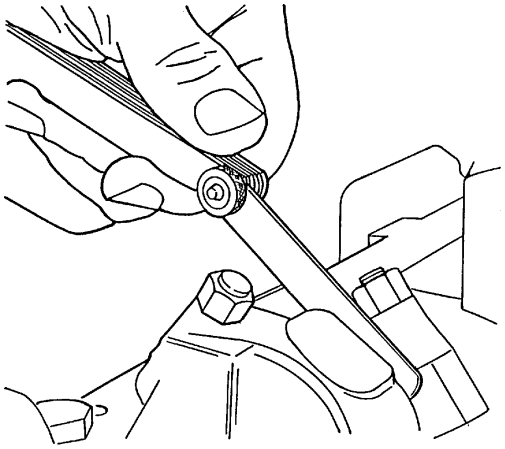


72362

6. If the clearance exceeds specifications, select a new, correct size bearing and measure the clearance.

NOTE: *Be sure to check what size bearing is being removed in order to determine proper replacement size bearing. If clearance cannot be brought to within specifications, the crankpin will have to be ground undersize. If the crankpin is already at maximum undersize, replace crankshaft.*

7. Coat the bearing surface with oil, install the rod cap and torque nuts to 45 lb. ft. (61 N·m).
8. When all connecting rod bearings have been installed, tap each rod lightly (parallel to the crankpin) to make sure they have clearance.
9. Measure all connecting rod side clearances between connecting rod caps as shown [Specifications - .006-.014 (0.152-0.356)"].



72891

Connecting Rod/Piston Assembly

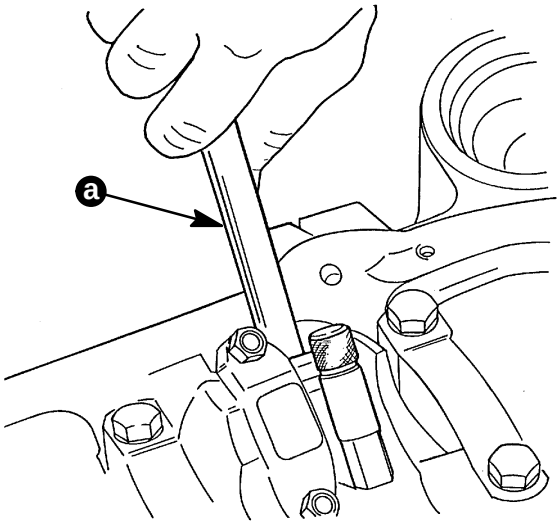
Removal

1. Remove as outlined:
   a. Oil pan and dipstick tube.
   b. Oil pump.
   c. Distributor and intake manifold.
   d. Cylinder heads.
2. Use a ridge reamer to remove any ridge and/or deposits from upper end of cylinder bore.

IMPORTANT: Before ridge and/or deposits are removed, turn crankshaft until piston is at bottom of stroke and place a cloth on top of piston to collect cuttings. After ridge and/or deposits are removed, turn crankshaft until piston is at top of stroke, then remove cloth and cuttings.

3. Mark connecting rods and bearing caps (left bank 1, 3, and 5; right bank 2, 4, and 6 from front to rear on same side as piston thrust).
4. Remove connecting rod cap and install connecting rod bolt guide (3/8-24) on bolts. Push connecting rod and piston assembly out of top of cylinder block.

NOTE: *It will be necessary to turn crankshaft slightly to disconnect and remove some connecting rod and piston assemblies.*

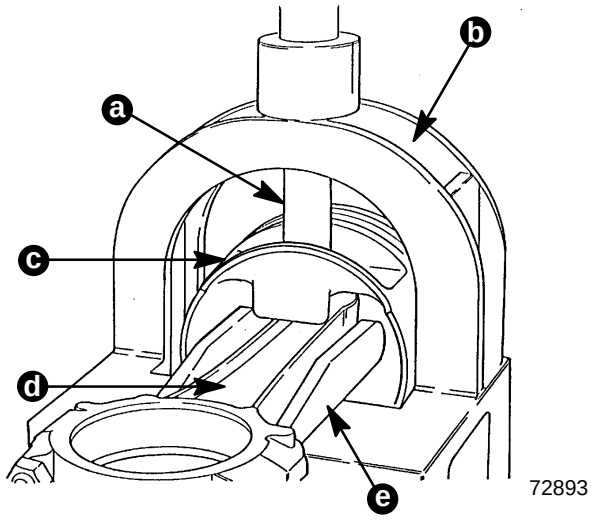


72892

a - Connecting Rod Bolt Guide (3/8-24) [J-5239]

Disassembly

Disassemble piston from connecting rod using piston pin remover as shown. Follow instructions supplied with kit.



72893

a - Piston Pin Remover (J-24086-B)
b - Arched Base
c - Piston
d - Connecting Rod
e - Rod Support

Cleaning and Inspection

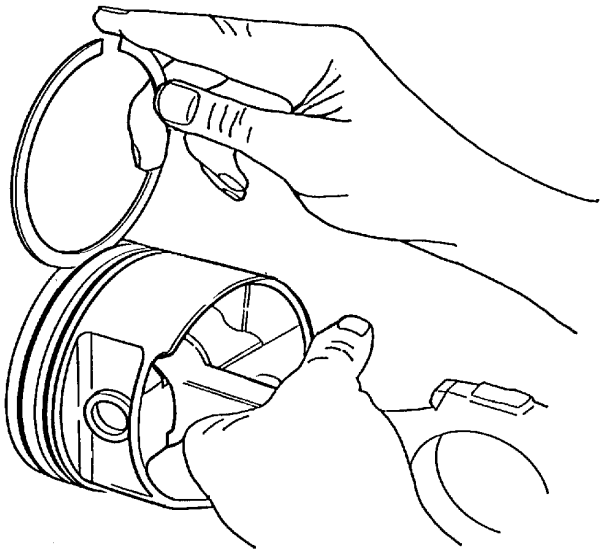
CONNECTING RODS

1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted and bent rods and inspect for nicks and cracks. Replace damaged connecting rods.

PISTONS

NOTE: *Cylinder bore and taper must be within specifications before pistons can be considered for re-use.*

1. Clean varnish from piston skirts with a cleaning solvent. DO NOT WIRE BRUSH ANY PART OF PISTON. Clean ring grooves with a groove cleaner and make sure oil ring holes are clean.
2. Inspect piston for cracked ring lands, skirts and pin bosses, wavy worn ring lands, scuffed or damaged skirts, and eroded areas at top of piston. Replace pistons which are damaged or show signs of excessive wear.
3. Inspect grooves for nicks and burrs that might cause rings to hang up.
4. Measure piston skirt and check clearance as outlined under “Piston Selection.”
5. Slip outer surface of a new top and second compression ring into respective piston ring groove and roll ring entirely around the groove to make sure that ring is free as shown. If binding occurs at any point, determine cause. If caused by ring groove, remove by dressing with a fine cut file. If binding is caused by a distorted ring, recheck with another ring.



72894

6. Proper clearance of piston ring in its piston ring groove is very important to provide proper ring action and reduce wear. Therefore, when fitting new rings, clearances between ring and groove surfaces should be measured. See “Specifications.”

72895

PISTON PINS

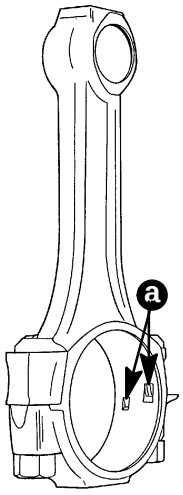
1. Piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, piston and piston pin are a matched set and not serviced separately.
2. Inspect piston pin bores and piston pins for wear. Piston pin bores and piston pins must be free of varnish and scuffing when measured. Measure piston pin with a micrometer and piston pin bore with a dial bore gauge or inside micrometer. If clearance is in excess of the .001 in. (0.025 mm) wear limit, replace piston and piston pin assembly.

Reassembly

PISTONS AND PISTON PINS

IMPORTANT: When reassembling pistons and connecting rods, the following must be kept in mind.

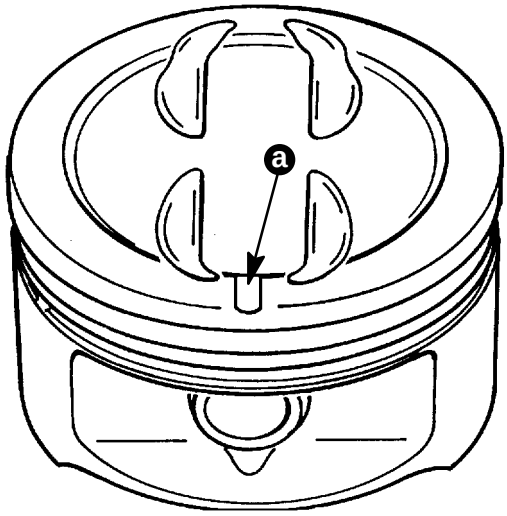
- **Piston and pin are machine fitted to each other and must remain together as a matched set. Do not intermix pistons and pins.**
- **If original pistons and/or connecting rods are being used, be sure to assemble pistons and connecting rods so they can be reinstalled in same cylinder from which they were removed.**
- **Connecting rod bearing tangs are always toward outside of cylinder block.**



72368

a - Rod Bearing Tangs

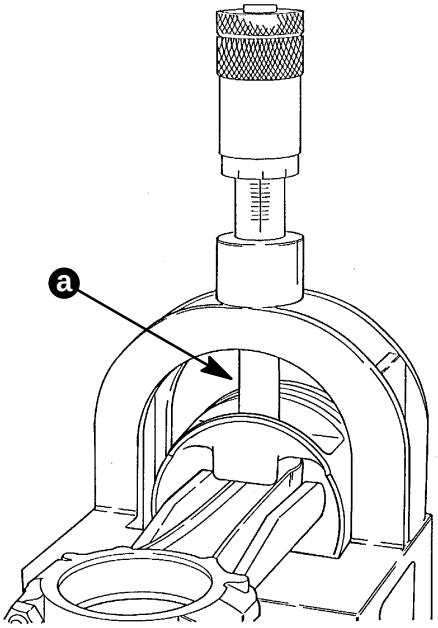
- **Notch in piston must be positioned facing toward the front of the engine.**



72896

a - Notch

1. Assemble piston to connecting rod using piston pin remover as shown. Follow instructions supplied with kit.



72897

a - Piston Pin Remover (J-24086-B)

2. Once assembled, check piston for freedom of movement (back-and-forth and up-and-down) on connecting rod. Piston should move freely in all directions. If it does not, piston pin bore is tight and piston/pin assembly must be replaced.

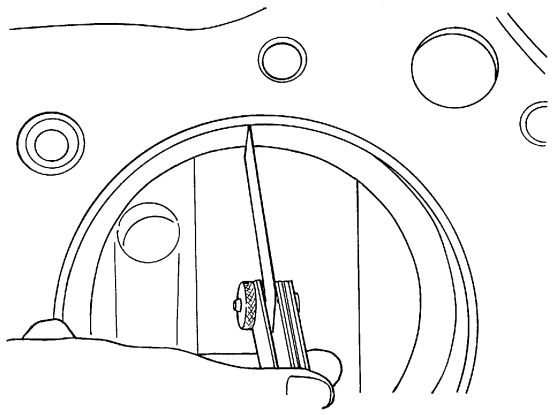
3. If a new connecting rod has been installed, mark connecting rod and cap (on side of rod and cap with slots for connecting rod bearing tangs) with cylinder number in which it will be installed.

PISTON RINGS

All compression rings are marked on upper side of ring. When installing compression rings, make sure that marked side is toward top of piston.

Oil control rings are a three-piece type, consisting of two rings and a spacer.

1. Select rings comparable in size to cylinder bore and piston size.
2. Slip compression ring in cylinder bore, then press ring down into cylinder bore about 1/4 in. (6 mm) (below ring travel). Be sure that ring is square with cylinder wall.
3. Measure gap between ends of ring with a feeler gauge as shown.



72372

4. If gap between ends of ring is below specifications, remove ring and try another for fit.
5. Fit each compression ring to cylinder in which it is going to be used.
6. Clean and inspect pistons, if not previously done.
7. Install piston rings as follows:
   a. Install oil ring spacer in groove and insert anti-rotation tang in oil hole.
   b. Hold spacer ends butted and install lower steel oil ring rail with gap properly located.
   c. Install upper steel oil ring rail with gap properly located.
   d. Flex the oil ring assembly to make sure ring is free. If binding occurs at any point, the cause should be determined and, if caused by ring groove, removed by dressing groove with a fine cut file. If binding is caused by a distorted ring, use a new ring.

IMPORTANT: Use piston ring expander (91-24697) for compression ring installation.

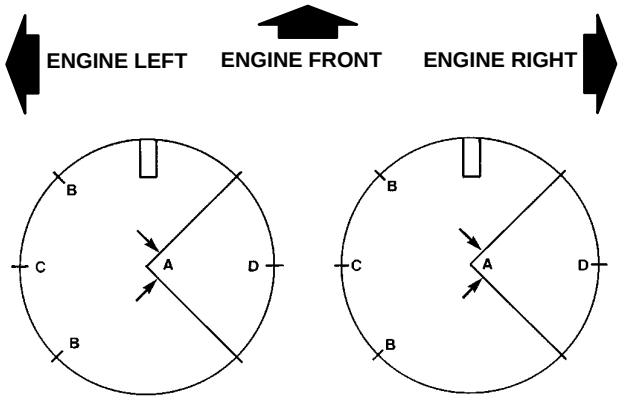
   e. Install lower compression ring with marked side up, using ring expander.
   f. Install top compression ring with marked side up, using ring expander.

Installation

IMPORTANT: Cylinder bores must be clean before piston installation. Clean with a light honing, as necessary. Then clean with hot water and detergent wash. After cleaning, swab bores several times with light engine oil and clean cloth, then wipe with a clean dry cloth.

1. Lubricate connecting rod bearings and install in rods and rod caps.
2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install connecting rod bolt guide (3/8-24) (J-5239) on connecting rod bolts.

IMPORTANT: Be sure ring gaps are properly positioned as shown.



1-3-5 Cylinders

2-4-6 Cylinders

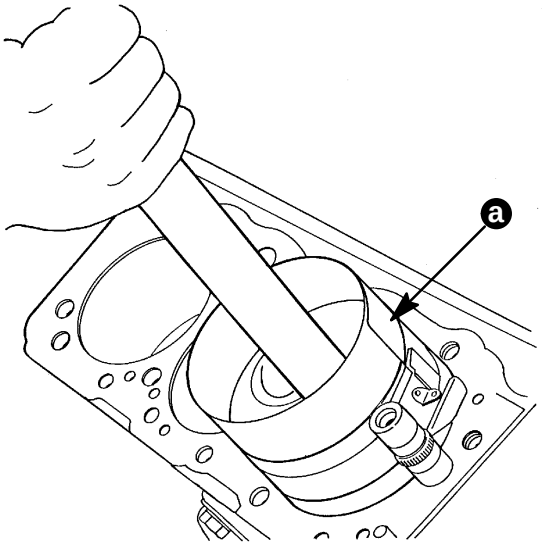
72373

Ring Gap Location

a - Oil Ring Spacer Gap (Tang in Hole or Slot within Arc)
b - Oil Ring Rail Gaps
c - 2nd Compression Ring Gap
d - Top Compression Ring Gap

4. Install each connecting rod and piston assembly in its respective bore. Install with connecting rod bearing tangs toward outside of cylinder block. Use piston ring compressor to compress rings. Guide connecting rod into place on crankshaft journal with connecting rod bolt guide. Use a hammer handle with light blows to install piston into bore. Hold ring compressor firmly against cylinder block until all piston rings have entered cylinder bore.

IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted, and used pistons in same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine (1, 3 and 5 in left bank and 2, 4 and 6 in right bank). Numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with new cylinder number.



72898

a - Piston Ring Compressor (J-8037)

5. Remove connecting rod bolt guide.
6. Install bearing caps and torque nuts to 20 lb. ft. (27 N·m), then tighten nuts an additional 60 degrees angular torque using a Torque Angle Gauge.
7. Check connecting rod side clearance as previously described.

NOTE: *If bearing replacement is required, refer to "Connecting Rod Bearings."*

8. Install as previously outlined:
   a. Oil pump.
   b. Dipstick and oil pan.
   c. Cylinder heads.
   d. Intake manifold.
   e. Distributor.
9. Fill crankcase with oil. Refer to Section 1 - "Maintenance."
10. Torque rocker arm nuts to 20 lb. ft. (27 N·m).

Crankshaft

Removal

1. Remove engine from boat.
2. Drain crankcase oil.
3. Remove as outlined:
   a. Starter.
   b. Flywheel housing.
   c. Drive coupler and flywheel.
   d. Belts.
   e. Water pump.
   f. Crankshaft pulley and torsional damper.
   g. Spark plugs.
   h. Oil pan and dipstick tube.
   i. Oil pump.
   j. Timing chain cover.
4. Turn crankshaft to align timing mark with camshaft mark.
5. Remove camshaft sprocket.
6. Remove rear main seal and retainer.
7. Make sure all bearing caps (main and connecting rods) are marked so they can be reinstalled in their original locations.
8. Remove connecting rod bearing caps, then push piston and rod assemblies toward heads.
9. Remove main bearing caps and carefully lift crankshaft out of cylinder block.
10. If new main and/or connecting rod bearings are to be installed, remove main bearing inserts from cylinder block and bearing caps, and/or connecting rod bearing inserts from connecting rod and caps. Install new bearings following procedures outlined.

Cleaning and Inspection

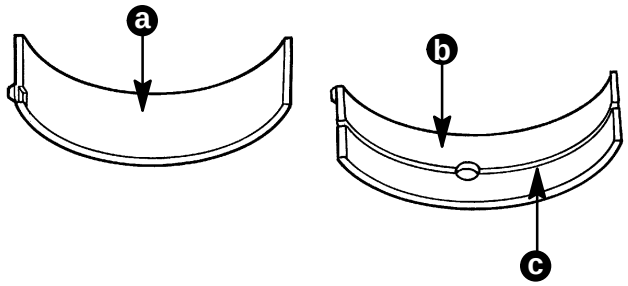
1. Wash crankshaft in solvent and dry with compressed air.
2. Measure main bearing journals and crankpin dimensions with a micrometer for out-of-round, taper or undersize (see “Specifications”).
3. Check crankshaft for runout (by supporting at front and rear main bearings journals in V-blocks) and check at front and rear intermediate journals with a dial indicator (see “Specifications”).
4. Replace or recondition crankshaft if not within specifications.

Installation

1. If a new crankshaft is being installed, remove timing sprocket from old crankshaft and reinstall on new crankshaft as outlined.

IMPORTANT: Be sure that all bearings and crankshaft journals are clean.

2. Install main bearings in engine block as follows.



72359

Main Bearing Inserts

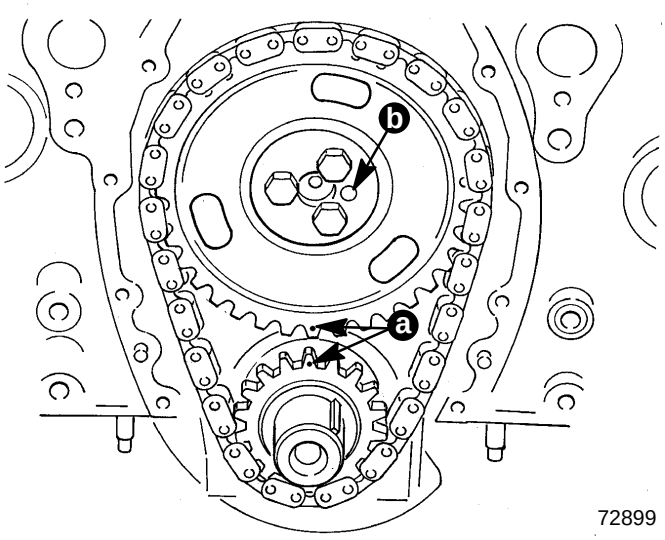
a - Lower Bearing Insert (Install in Cap)
b - Upper Bearing Insert (Install in Block)
c - Oil Groove

3. Carefully lower crankshaft into place. Be careful not to damage bearing surface.
4. Check clearance of each main bearing, following procedure outlined under “Main Bearings.” If bearing clearances are satisfactory, apply engine oil to journals and bearings.
5. Install main bearing caps. Torque bolts to 75 lb. ft. (102 N·m). When tightening rear main bearing cap, follow procedure outlined under “Main Bearings.”
6. Check crankshaft end play as previously outlined.
7. Install rear main seal retainer and seal. Torque fasteners to 133 lb. in. (15 Nm).
8. Check clearance for each connecting rod bearing, following procedure under “Connecting Rod Bearings.” If bearing clearances are satisfactory, apply engine oil to journals and bearings.
9. Install rod caps and torque nuts to 45 lb. ft. (61 N·m).
10. Turn crankshaft so mark on timing sprocket is facing camshaft.
11. Install as outlined:
    a. Timing chain and sprocket on camshaft - align marks with crankshaft.
    b. Timing chain cover.
    c. Oil pump.
    d. Dipstick tube and oil pan.
    e. Spark plugs.
    f. Torsional damper and crankshaft pulley.
    g. Water pump.
    h. Belts.
    i. Flywheel and drive coupler.
    j. Flywheel housing.
    k. Starter.
12. Install new oil filter. Fill crankcase with oil.

Timing Chain and Sprocket

Removal

1. Remove torsional damper, oil pan and crankcase front cover as previously outlined.
2. Turn crankshaft until timing marks on crankshaft and camshaft sprockets are in alignment as shown.



a - Timing Marks Aligned
b - Locating Pin

3. Remove camshaft sprocket and timing chain. (If sprocket does not come off easily, a light tap on the lower edge of the sprocket, using a plastic mallet, should dislodge it.)
4. If crankshaft sprocket requires replacement, remove as outlined.

Cleaning and Inspection

1. Clean all parts in solvent and dry with compressed air.
2. Inspect timing chain for wear and damage.
3. Inspect sprockets for wear and damage.

Installation - Timing Chain

1. If crankshaft sprocket was removed, install as outlined in “Crankshaft Sprocket.”
2. Install timing chain on camshaft sprocket. Hold sprocket vertical with chain hanging down. Align marks on camshaft and crankshaft sprockets.

IMPORTANT: Do not attempt to drive sprocket on camshaft, as welsh plug at rear of engine can be dislodged.

3. Install sprocket on camshaft. Torque bolts to 18 lb. ft. (24 N·m).
4. Lubricate timing chain with engine oil. Install crankcase front cover and torsional damper as outlined.

⚠CAUTION

When timing marks are aligned in this procedure, the No. 4 cylinder is on compression (TDC); therefore, if the distributor is to be installed, the rotor MUST BE positioned at the No. 4 post on the distributor cap.

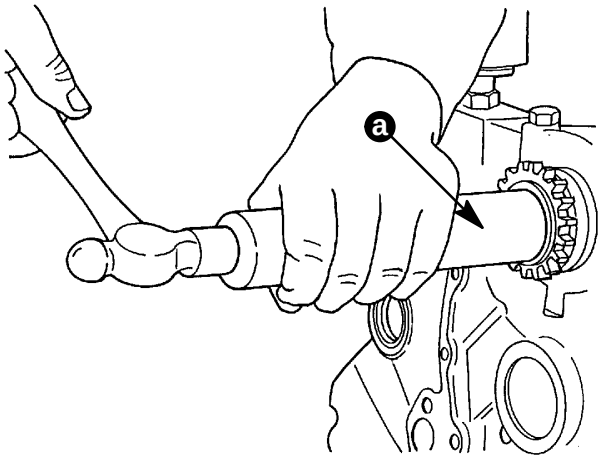
Crankshaft Sprocket

Removal

1. Remove torsional damper and crankcase front cover as previously outlined.
2. Remove camshaft timing chain as outlined, and using crankshaft gear and sprocket puller (P/N J-5825-A), remove crankshaft sprocket.

Installation

1. Using crankshaft gear and sprocket installer, as shown, install sprocket on crankshaft.



72377

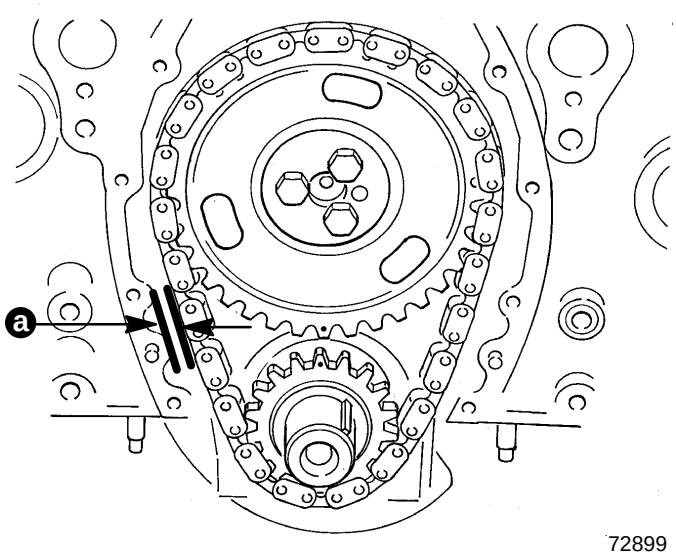
a - Crankshaft Gear and Sprocket Installer (J-5590)

2. Install timing chain as outlined.
3. Install crankcase cover and torsional damper as outlined.

Checking Timing Chain Deflection

With timing chain and sprockets installed, check timing chain deflection, as follows:

1. Rotate camshaft (in either direction) to place tension on one side of the chain.
2. Establish a reference point on the block (on taut side of chain) and measure from this point to the chain.
3. Rotate camshaft in the opposite direction to slacken the chain, then force chain out with fingers and again measure the distance between reference point and timing chain.
4. The deflection is the difference between these two measurements. If the deflection exceeds 3/4 in. (19 mm), timing chain should be replaced.



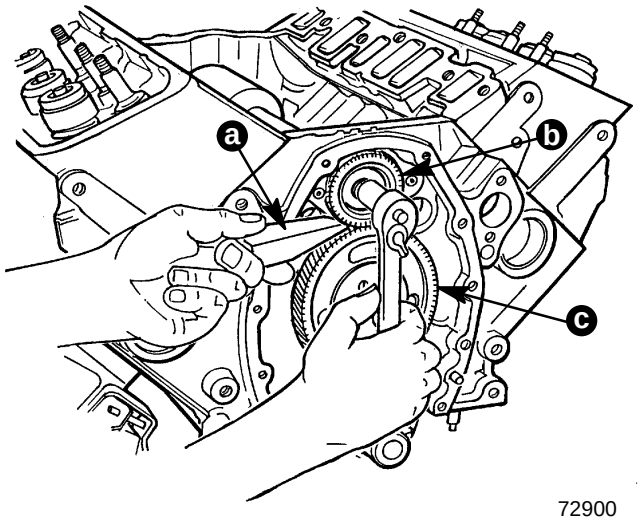
72899

a - Reference Point

Balance Shaft/Gears

Removal

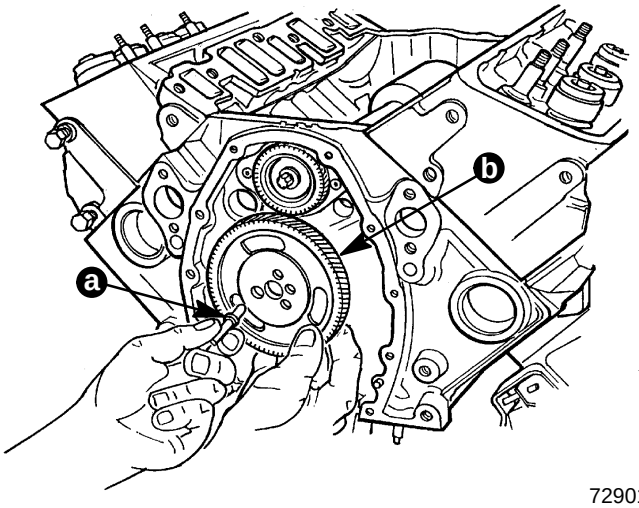
1. Remove manifold as previously outlined.
2. Remove crankcase front cover as previously outlined.
3. Remove timing chain as previously outlined.
4. Insert hard wood wedge between gear teeth and remove TORX bolt retaining balance shaft driven gear. Remove gear.



72900

a - Wedge
b - Driven Gear
c - Drive Gear

5. Unscrew stud and remove balance shaft drive gear on camshaft as shown.



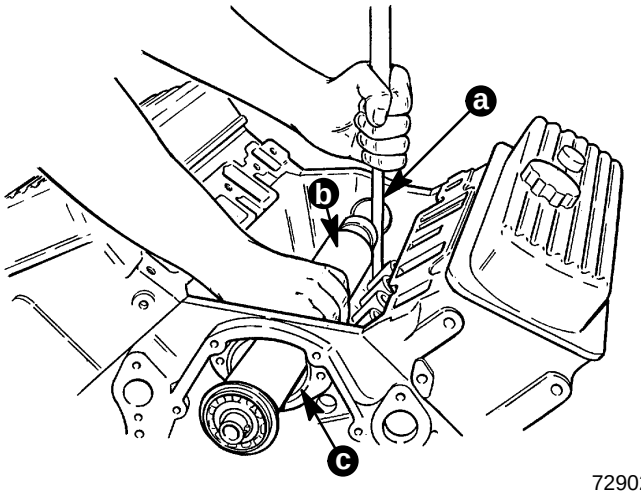
72901

a - Stud
b - Drive Gear

6. Remove two TORX bolts retaining balance shaft thrust plate.

IMPORTANT: Care should be taken in next step as damage to cylinder block and/or balance shaft could result.

7. Insert pry bar in aft section between balance shaft and cylinder block. Gently applying forward pressure, remove balance shaft from bearing housing and cylinder block.

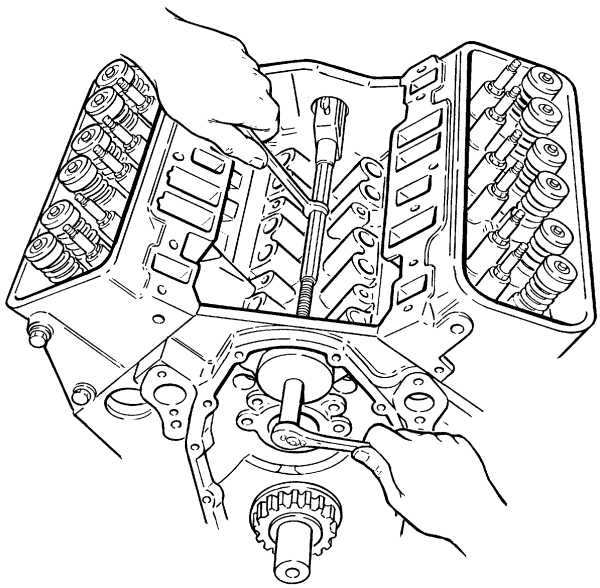


72902

a - Pry Bar
b - Balance Shaft
c - Bearing Housing

NOTE: *When replacing balance shaft rear bearing, place a cloth in valley to prevent any debris from entering the crankcase.*

8. Balance shaft rear bearing can be replaced using balance shaft remover and installer tool in conjunction with bearing puller.



72903

Cleaning and Inspection

1. Wash balance shaft in solvent and blow dry with compressed air.
2. Inspect rear bearing for wear or damage (refer to “Specifications”).

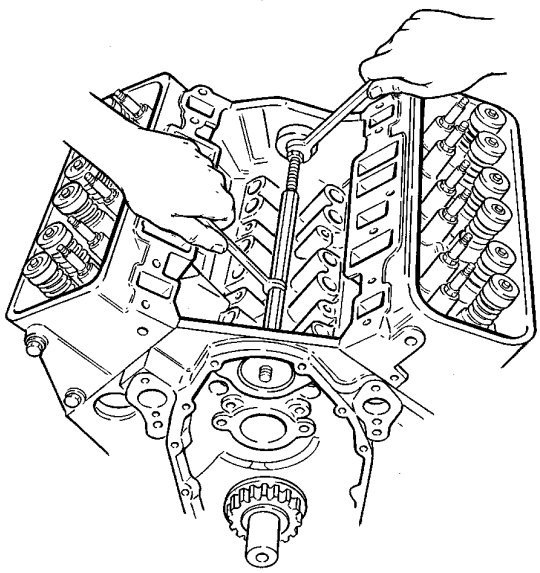
NOTE: *Front bearing is not serviceable and may be replaced only with the balance shaft assembly.*

3. Inspect front bearing for secure fit on shaft or excessive side to side play. Also check for scored bearings or roughness while rotating.
4. Inspect front cylinder block bore for scoring or evidence of bearing spinning in bore.
5. Inspect gears for chips or excessive wear on teeth.
6. Inspect balance shaft gear key way and shaft dowel pin for excessive wear.

Installation

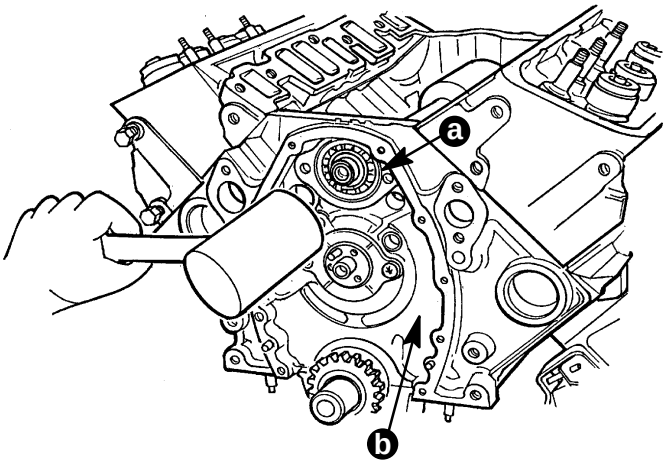
NOTE: *GM shim (10229872) is placed on installer tool prior to the bearing. This will assure proper depth setting of rear bearing when installed.*

1. Use balance shaft remover and installer tool along with GM shim to insert bearing.



73176

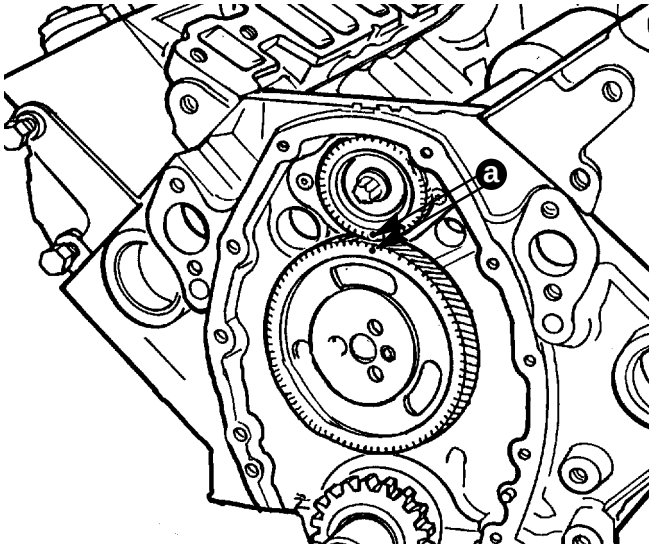
2. Lubricate bearings with engine oil and install balance shaft.
3. Using a soft face mallet, tap shaft until front bearing retaining ring seats against cylinder block.



72904

a - Retaining Ring
b - Cylinder Block

4. Install thrust plate and two TORX bolts. Torque to 120 lb. in. (14 N·m).
5. Install driven gear on balance shaft.
6. Align marks on drive and driven gear and install drive gear on camshaft.

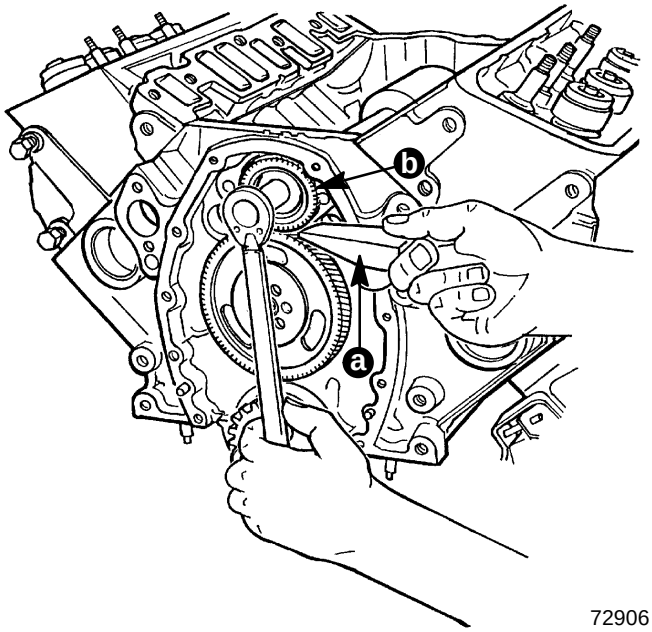


72905

a - Alignment Marks

7. Install bolts to retain camshaft sprocket and torque to 20 ft. in. (27 N·m).
8. Apply thread adhesive to threads of balance shaft bolt and install.

9. Insert hard wood wedge between gear teeth and torque driven gear retaining bolt to 15 lb. ft. (20 N·m), then tighten bolt an additional 35 degrees angular torque using a Torque Angle Gauge.



72906

a - Wedge
b - Driven Gear

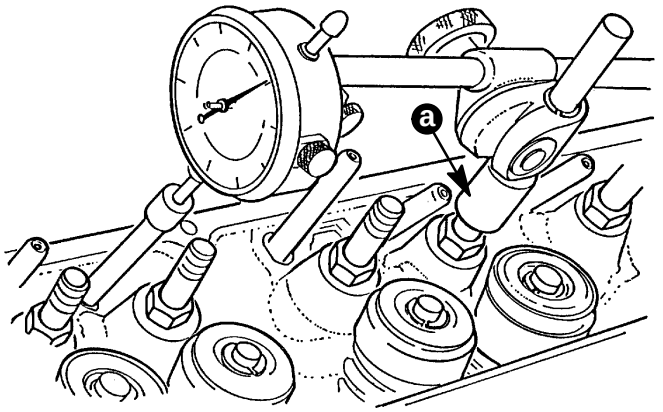
10. Install timing chain as previously outlined.
11. Install crankcase front cover as previously outlined.
12. Install manifold as previously outlined.

Camshaft

Measuring Lobe Lift

NOTE: *Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each push rod in consecutive order and record readings.*

1. Remove valve mechanism as previously outlined.
2. Position indicator with ball socket adaptor tool on push rod. Be sure that push rod is in lifter socket.



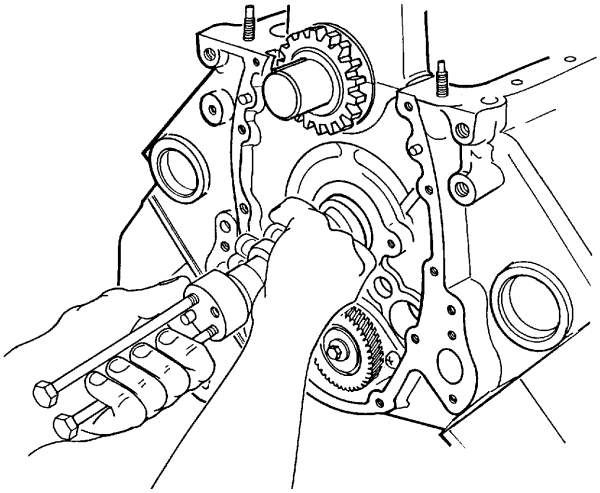
72907

a - Ball Socket Adaptor Tool (J-8520-1)

3. Rotate crankshaft torsional damper slowly in direction of rotation until lifter is on heel of cam lobe. At this point, push rod will be in its lowest position.
4. Set dial indicator on zero, then rotate balancer slowly (or attach an auxiliary starter switch and “bump” engine over) until push rod is in fully raised position.
5. Compare total lift, recorded from dial indicator, with “Specifications.”
6. Continue to rotate engine until indicator reads zero. This will be a check on accuracy of original indicator reading.
7. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
8. Install rocker arm and push rod. Torque nuts to 20 lb. ft. (27 N·m).

Removal

1. Remove valve lifters as previously outlined.
2. Remove crankcase front cover as previously outlined.
3. Remove camshaft as follows:
   a. Remove timing chain, sprocket and camshaft thrust plate.
   b. Install two 5/16-18 x 5 in. bolts in camshaft bolt holes and carefully remove camshaft as shown.

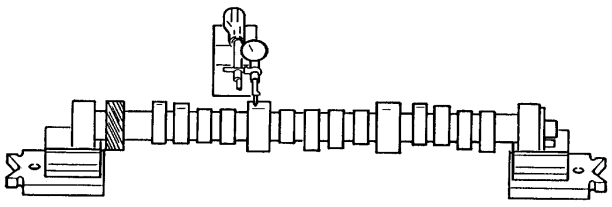


72908

Inspection

Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed .001 in. (0.025 mm) out-of-round, camshaft should be replaced.

Also check camshaft for alignment with V-blocks and dial indicator which indicates exact amount camshaft is out of true. If out more than .002 in. (0.051 mm) (dial indicator reading) camshaft should be replaced.



72909

Checking Camshaft Alignment

Installation

1. Install camshaft as follows:
   a. Install two 5/16-18 x 5 in. bolts in camshaft bolt holes, then lubricate camshaft journals with engine oil and install camshaft, being careful not to damage bearings.
   b. Lubricate camshaft lobes with General Motors Cam and Lifter Prelube or equivalent.
   c. Install timing chain as previously outlined.
2. Install crankcase front cover and valve lifters as previously outlined.

Camshaft Bearings

Removal

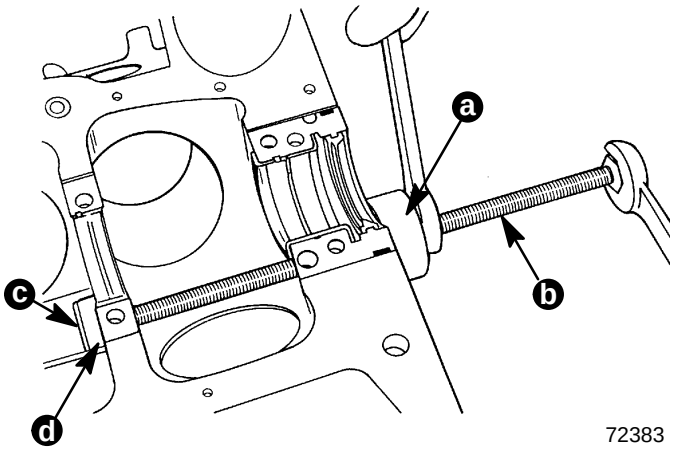
Camshaft bearings can be replaced while engine is disassembled for overhaul or without complete disassembly. To replace bearings without complete disassembly, remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place. Before removing crankshaft, fasten connecting rods against sides of engine so that they will not interfere while replacing camshaft bearings.

1. With camshaft and crankshaft removed, drive camshaft rear plug from cylinder block.

NOTE: *This procedure is based on removal of bearings from center of engine first, thus requiring a minimum amount of turns to remove all bearings.*

2. Using camshaft bearing remover and installer set (J-6098-01) (with nut and thrust washer installed to end of threads), position pilot in front camshaft bearing and install puller screw through pilot.
3. Install tool with shoulder toward bearing. Be sure a sufficient amount of threads are engaged.
4. Using two wrenches, hold puller screw while turning nut. When bearing has been pulled from bore, remove tool and bearing from puller screw.

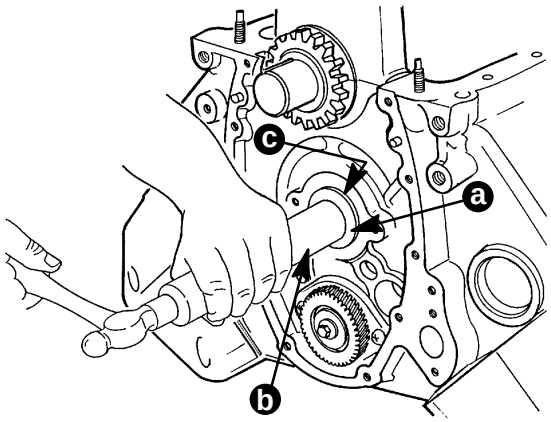
5. Remove remaining bearings (except front and rear) in same manner. It will be necessary to position pilot in rear camshaft bearing to remove rear intermediate bearing.



72383

a - Index Point
b - Puller Screw
c - Driver
d - Bearing

6. Assemble driver on driver handle and remove front and rear camshaft bearings by driving toward center of cylinder block.



72870

a - Driver
b - Driver Handle
c - Bearing (Hidden In This View)

Inspection

Clean camshaft bearing bores in cylinder block with solvent and blow out with compressed air. Be sure grooves and drilled oil passages are clean.

Installation

Front and rear bearings must be installed last as pilot will not fit into bearing bores if bearings are installed.

Lubricate outer surface of new camshaft bearings with engine oil to ease installation.

IMPORTANT: All camshaft bearings are not the same. Be sure to install bearings in proper locations (Indicated by bearing manufacturer) and to position bearings as follows (directional references are in reference to engine in its normal operating position):

- **Front bearing must be positioned so that oil holes are equal distance from 6 o'clock position in the block. Intermediate and center bearings must be positioned so that oil holes are at the 5 o'clock position (toward left side of block and at a position even with bottom of cylinder bore). Rear bearing must be positioned so that oil hole is at the 12 o'clock position.**

1. Installing intermediate and center bearings:

   a. Install nut and thrust washer all the way onto puller screw, then position pilot in front camshaft bearing bore and insert screw through pilot.

   b. Index center camshaft bearing, then position appropriate size remover and installer tool in bearing and thread puller screw into tool. Be sure at least 1/2 in. (13 mm) of threads are engaged.

   c. Using two wrenches, hold puller screw and turn nut until bearing has been pulled into position. Remove the remover and installer tool and check to ensure that oil hole(s) in bearing are positioned correctly.

   d. Install intermediate bearings in same manner being sure to index bearings correctly. It will be necessary to position pilot in rear camshaft bearing bore to install rear intermediate bearing.

2. Installing front and rear bearings:

   a. Install appropriate size remover and installer tool on drive handle.

   b. Index front bearing (as explained in “Important” above), and drive it into position with tool. Check position of oil hole(s) in bearing to ensure bearing is positioned correctly.

   c. Install rear bearing in same manner, being sure to index bearing correctly.

3. Install a new camshaft rear plug.

IMPORTANT: Plug must be installed flush to 1/32 in. (0.8 mm) deep and must be parallel with rear surface of cylinder block.

4. Install crankshaft and camshaft as previously outlined.

Cylinder Block

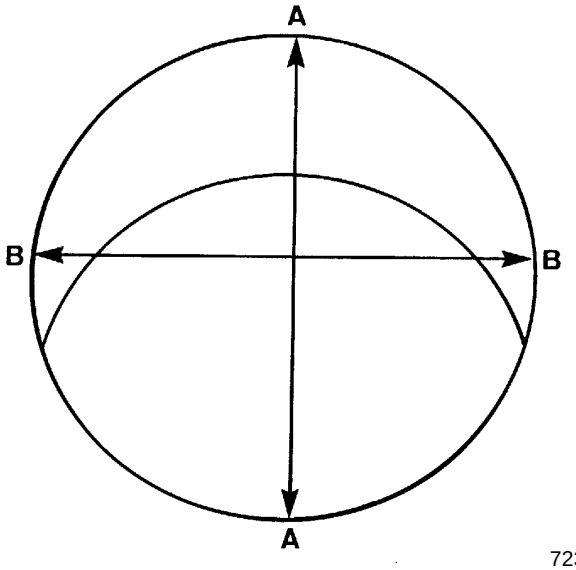
Cleaning and Inspection

1. Remove all engine components as previously outlined.
2. Wash cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
3. Remove oil gallery plugs and clean all oil passages.
4. Remove expansion plugs.

NOTE: *These plugs may be removed with a sharp punch, or they may be drilled and pried out.*

5. Clean and inspect water passages in cylinder block.
6. Inspect cylinder block for cracks in cylinder walls, water jacket valve lifter bores and main bearing webs.

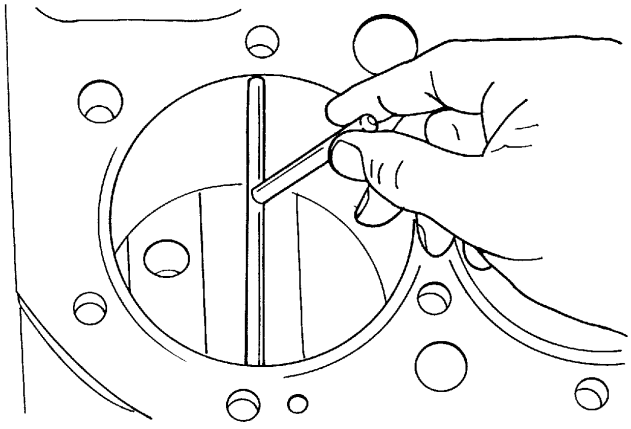
7. Measure cylinder walls for taper, out-of-round or excessive ridge at top of ring travel. This should be done with a dial indicator or inside micrometer. Carefully work gauge up and down cylinder to determine taper and turn it to different points around cylinder wall to determine out-of-round condition. If cylinders exceed specifications, boring and/or honing will be necessary.



72385

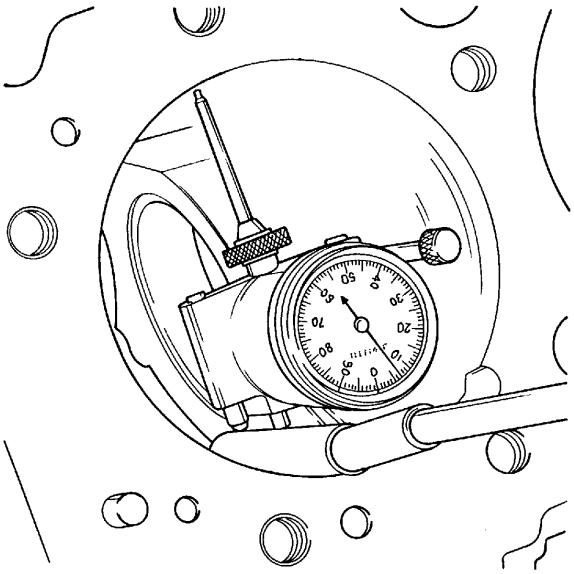
Cylinder Measurement

a - At Right Angle to Centerline on Engine
b - Parallel to Centerline of Engine
“Out of Round” is the difference between “A” and “B”.
“Taper” is the Difference between Measurement “A” At Top of Cylinder Bore and “A” Measurement at Bottom of Cylinder Bore



72386

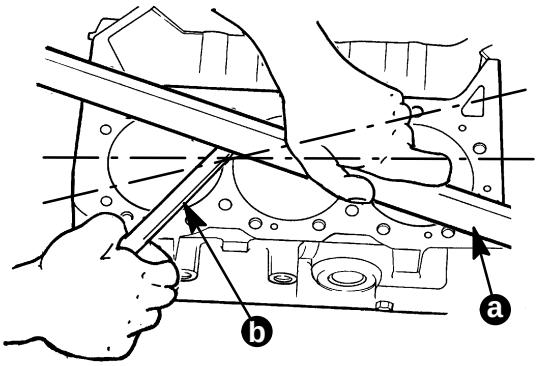
Measuring Cylinder Bore



72387

Measuring Cylinder Bore

8. Check cylinder head gasket surfaces for warpage with a machinist's straight-edge and a feeler gauge, as shown. Take measurements diagonally across surfaces (both ways) and straight down center. If surfaces are warped more than .003 in. (0.07 mm) in a 6 in. area or .007 in. (0.2 mm) overall, block must be resurfaced by an automotive machine shop.



72910

a - Machinist's Straight Edge
b - Feeler Gauge

CYLINDER CONDITIONING

1. Performance of the following operation depends upon engine condition at time of repair.

2. If cylinder block inspection indicates that block is suitable for continued use (except for out-of-round or tapered cylinders), they can be conditioned by honing or boring.

3. If cylinders have less than .005 in. (0.127 mm) taper or wear, they can be conditioned with a hone and fitted with high limit standard size piston. A cylinder bore of more than .005 in. wear or taper may not clean up entirely when fitted to a high limit piston. To entirely clean up the bore, it will be necessary to bore for an oversize piston. If more than .005 in. taper or wear, bore and hone to smallest oversize that will permit complete resurfacing of all cylinders.

4. When pistons are being fitted and honing is not necessary, cylinder bores may be cleaned with a hot water and detergent wash. After cleaning, swab cylinder bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth.

CYLINDER BORING

1. Before using any type boring bar, file off top of cylinder block to remove dirt or burrs. This is very important to prevent boring bar tilt, with result that bored cylinder wall is not at right angles to crankshaft.

2. Measure piston to be fitted with a micrometer, measuring at center of piston skirt and at right angles to piston pin. Bore cylinder to same diameter as piston and hone to give specified clearance.

NOTE: *Hone cylinders as outlined under "Cylinder Honing" and "Piston Selection," following.*

3. Carefully observe instructions furnished by manufacturer of equipment being used.

CYLINDER HONING

1. Follow hone manufacturer's recommendations for use of hone and cleaning and lubrication during honing.

2. Occasionally, during the honing operation, thoroughly clean cylinder bore and check piston for correct fit in cylinder.

3. When finish-honing a cylinder bore to fit a piston, move hone up and down at a sufficient speed to obtain very fine uniform surface finish marks in a crosshatch pattern of approximately 30 degrees to cylinder bore. Finish marks should be clean but not sharp, free from imbedded particles and torn or folded metal.

4. Permanently mark piston (for cylinder to which it has been fitted) and proceed to hone cylinders and fit remaining pistons.

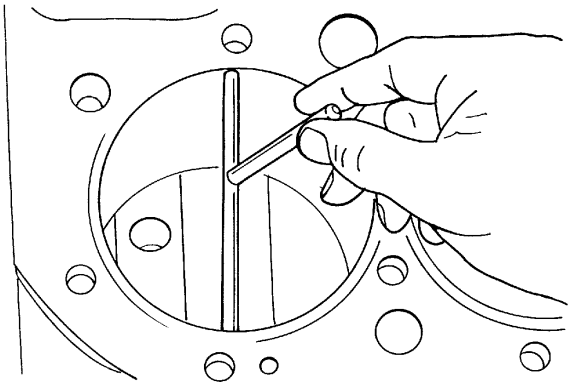
IMPORTANT: Handle pistons with care and do not attempt to force them through cylinder until cylinder is honed to correct size, as this type piston can be distorted by careless handling.

5. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. It is extremely essential that a good cleaning operation be performed. If any abrasive material remains in cylinder bores, it will rapidly wear new rings and cylinder bores in addition to bearings lubricated by the contaminated oil. Swab bores several times with light engine oil on a clean cloth, then wipe with a clean dry cloth. Cylinder should not be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

PISTON SELECTION

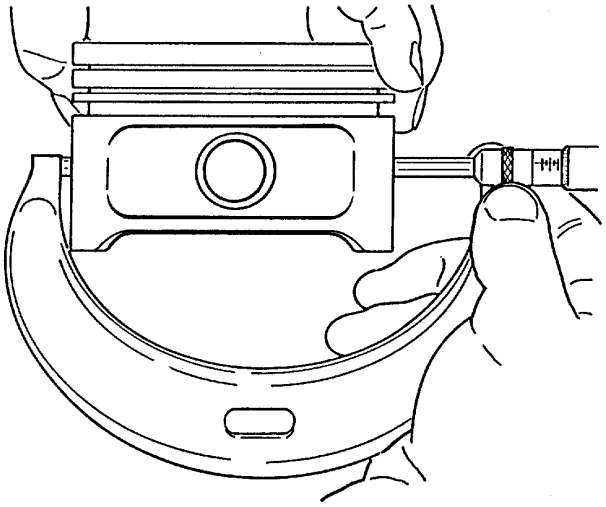
1. Check used piston to cylinder bore clearance as follows:

   a. Measure cylinder bore diameter with a telescope gauge 2-1/2 in. (64 mm) from top of cylinder bore as shown.



72386

   b. Measure piston diameter at skirt across center line of piston pin as shown.



72911

   c. Subtract piston diameter from cylinder bore diameter to determine piston-to-bore clearance.

   d. Determine if piston-to-bore clearance is in acceptable range shown in "Specifications."

2. If used piston is not satisfactory, determine if a new piston can be selected to fit cylinder bore within acceptable range.

3. If cylinder bore must be reconditioned, measure new piston diameter (across centerline of piston pin), then hone cylinder bore to correct clearance (preferable range).

4. Mark piston to identify cylinder for which it was fitted.

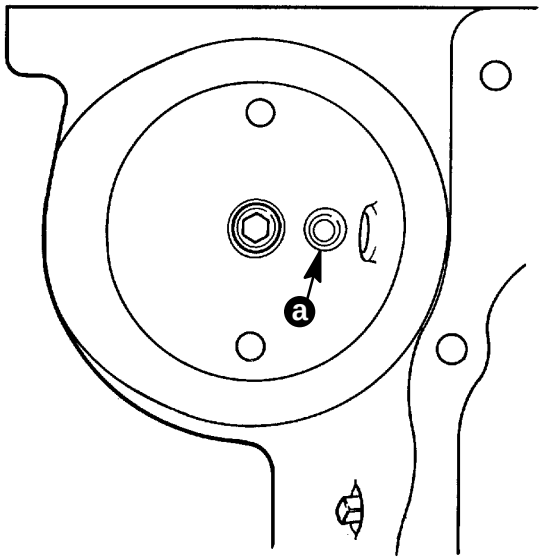
Oil Filter By-Pass Valve

Inspection and/or Replacement

Oil by-pass valve should be inspected whenever engine is disassembled for major repair or whenever inadequate oil filtration is suspected.

Refer to “Engine Parts List” when ordering parts for oil filter by-pass valve.

1. Remove oil filter from cylinder block and remove by-pass valve.
2. Clean by-pass valve in solvent and blow dry with compressed air.
3. Inspect fiber valve for cracks or other damage. Check that valve fits tightly against its seat. Push valve down and release it. Valve should return freely to its seat. If valve operation is questionable, by-pass valve should be replaced.



72912

Typical By-Pass Valve

a - Fiber Valve (Be Sure Valve Fits Tightly Against the Seal)

4. Wipe out valve chamber in cylinder block to remove any foreign material.
5. Install by-pass valve or cylinder block adaptor to engine block.
6. Lubricate oil filter rubber seal and install hand-tight only.

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

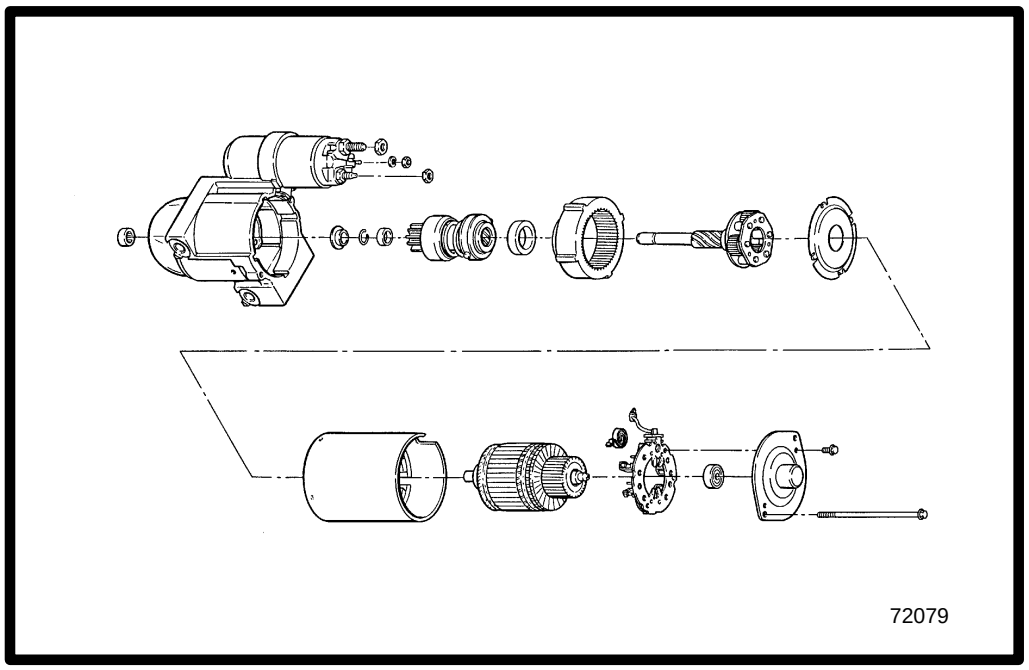
THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

ELECTRICAL SYSTEMS

4

A



STARTING SYSTEM

Index

Table of Contents

	Page
Starters (PG260 And Delco-Remy)	4A-1
Specifications	4A-1
Torque Specifications	4A-2
Lubricants, Sealers and Adhesives	4A-2
Identification	4A-2
Battery Cable Recommendations	4A-2
Starting System Components For PG260 (Typical Diagram)	4A-3
Starting System Components for Delco-Remy Direct Drive Starter (Typical Diagram)	4A-4
PG 260 Starter Motor (Exploded View)	4A-5
Delco-Remy Starter Motor (Exploded View)	4A-6
Replacement Parts Warning	4A-7
Maintenance	4A-7
Testing	4A-7
Storage	4A-8
Positive Current Flow	4A-8
Description	4A-8
Solenoid Switch	4A-8
Periodic Inspection	4A-8
Starter Motor Repair	4A-9
Removal	4A-9
Disassembly	4A-9
Cleaning and Inspection	4A-11
Armature Tests	4A-11
Armature Bearing (Commutator End)	4A-11
Gear Bearing	4A-12
Shaft Assembly Bearing	4A-12
Drive End Housing Bearing	4A-12
Brushes and Brush Holder	4A-13
Reassembly	4A-14
Clearances	4A-16
Installation	4A-17
Standard Starter Slave Solenoid	4A-17
Testing/Replacement	4A-17
Delco PG 260	4A-18
Identification	4A-18
Replacement Parts Warning	4A-18
Maintenance	4A-18
Solenoid Switch	4A-18
Periodic Inspection	4A-18
Starter Motor Repair	4A-18
Removal	4A-18
Disassembly	4A-19
Cleaning and Inspection	4A-21
Armature Tests	4A-21
Brushes and Brush Holder	4A-22
Reassembly	4A-22
Clearances	4A-25
Installation	4A-26

Index

Starters (PG260 And Delco-Remy)
Specifications

DELCO-REMY DIRECT DRIVE STARTER

Delco Identification Number	Engine Rotation	No Load Test					Brush Spring Tension Oz.(Grams)
		Volts	Min. Amps	Max Amps	Min RPM	Max RPM	
1998317 10455602	LH	10.6	70	120	5,400	10,800	56-105 (1588-2976)
Pinion Clearance		.010-.140 (.025-3.5 mm)					
Commutator End Frame Gap		.025 (0.6 mm) Max					

PG 260 STARTER

Delco Identification Number	No Load Test					Brush Spring Tension Oz.(Grams)
	Volts	Min Amps	Max Amps	Min RPMS	Max RPMS	
9000820 9000821 9000819	10.6	60	95	2750	2750	83-104 (2353-2948)
Pinion Clearance	.010-.160 (0.25-4.00)					
Bearing Depth	.011-.014 (0.28-0.38)					
Bearing Depth	.099-.017 (.025-.045)					

Index

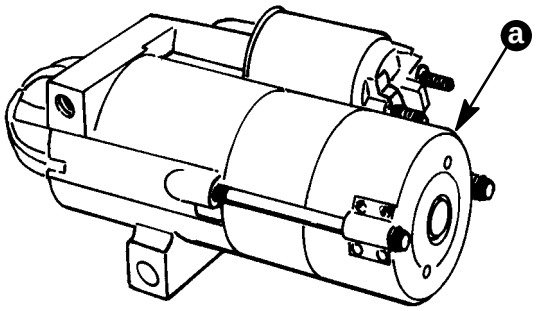
Torque Specifications

Description	Lb. In.	Lb. Ft.	N·m
Starter Mounting Bolts Direct Drive		50	68
Starter Mounting Bolts PG 260		30	41
Commutator End Frame (End Cap)	110		12
Battery Cables	Securely		

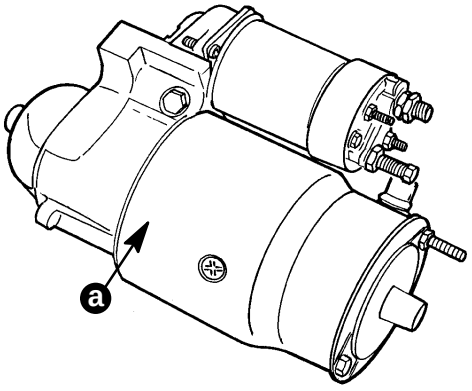
Lubricants, Sealers and Adhesives

Description	Part Number
Quicksilver Liquid Neoprene	92-25711-2
Quicksilver 2-C-4 Marine Lubricant With Teflon	92-825407A3
Quicksilver Perfect Seal	92-34227-1

Identification



Permanent Magnet Gear Reduction (PG260) Starter Motor



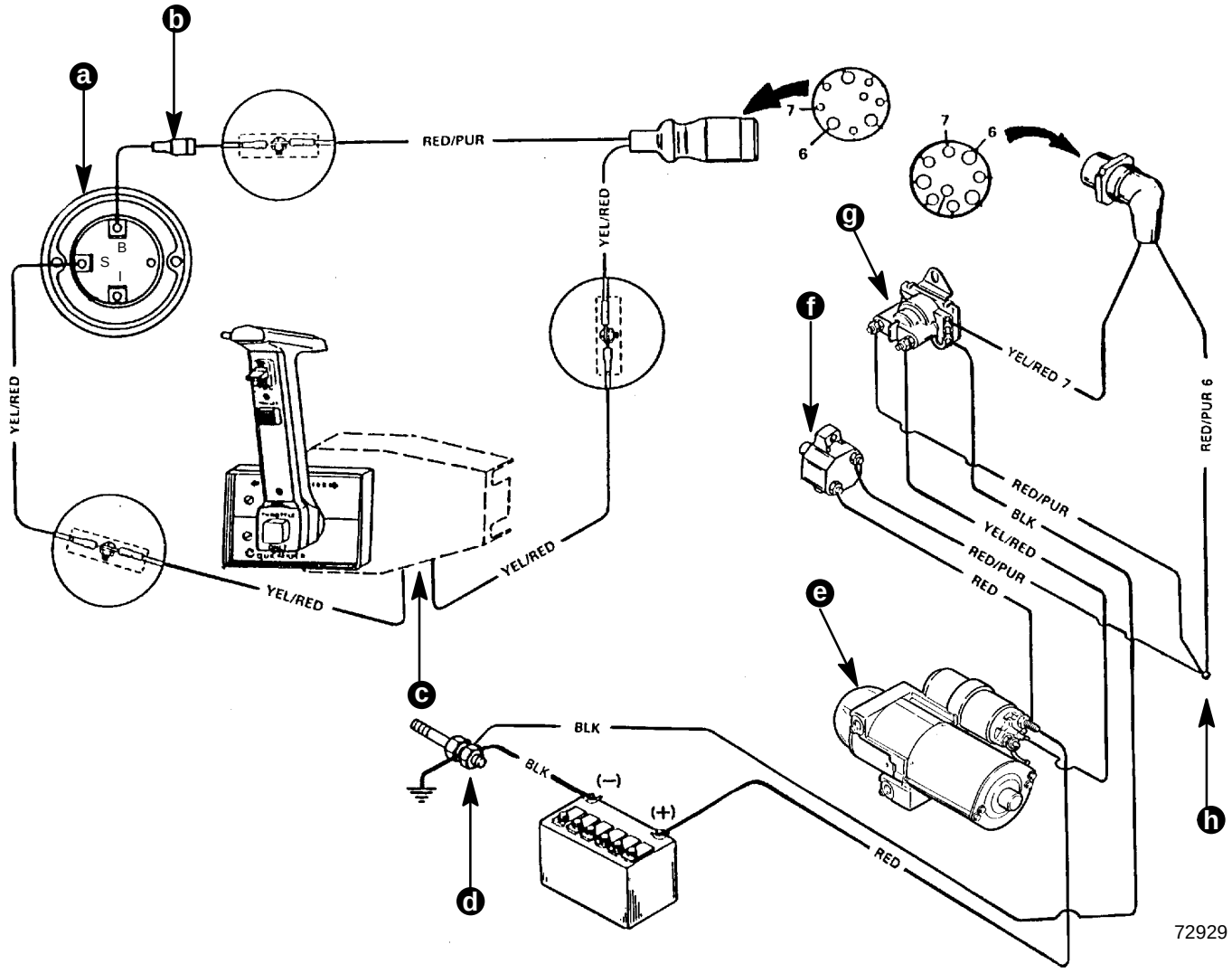
72789

Delco-Remy Direct Drive Starter Motor

Battery Cable Recommendations

Cable Length Feet (Meters)	Cable Gauge (mm)
Up to 3.5(1.1)	4 (25mm2)
3.5-6 (1.1-1.8)	2 (35mm2)
6-7.5(1.8-2.3)	1 (50mm2)
7.5-9.5(2.3-2.9)	0 (50mm2)
8.5-12(2.9-3.7)	00 (70mm2)
12-15(3.7-4.6)	000 (95mm2)
15-19(4.6-5.8)	0000 (120mm2)

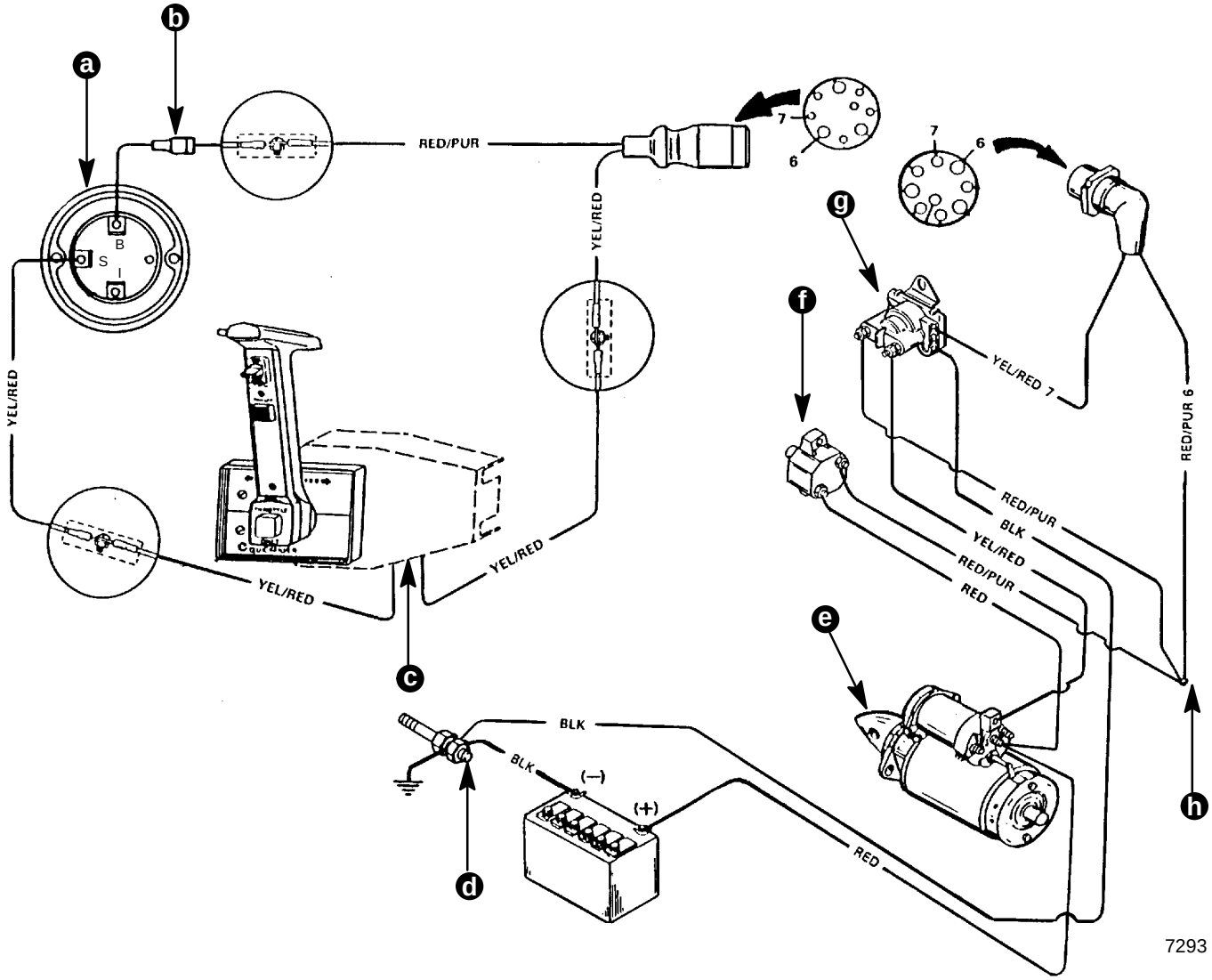
Starting System Components For PG260 (Typical Diagram)



a - Ignition Switch
b - 20 Ampere Fuse
c - Neutral Safety Switch
d - Ground Stud
e - Starter Motor
f - Circuit Breaker
g - Starter Slave Solenoid
h - Wire Junction

Index

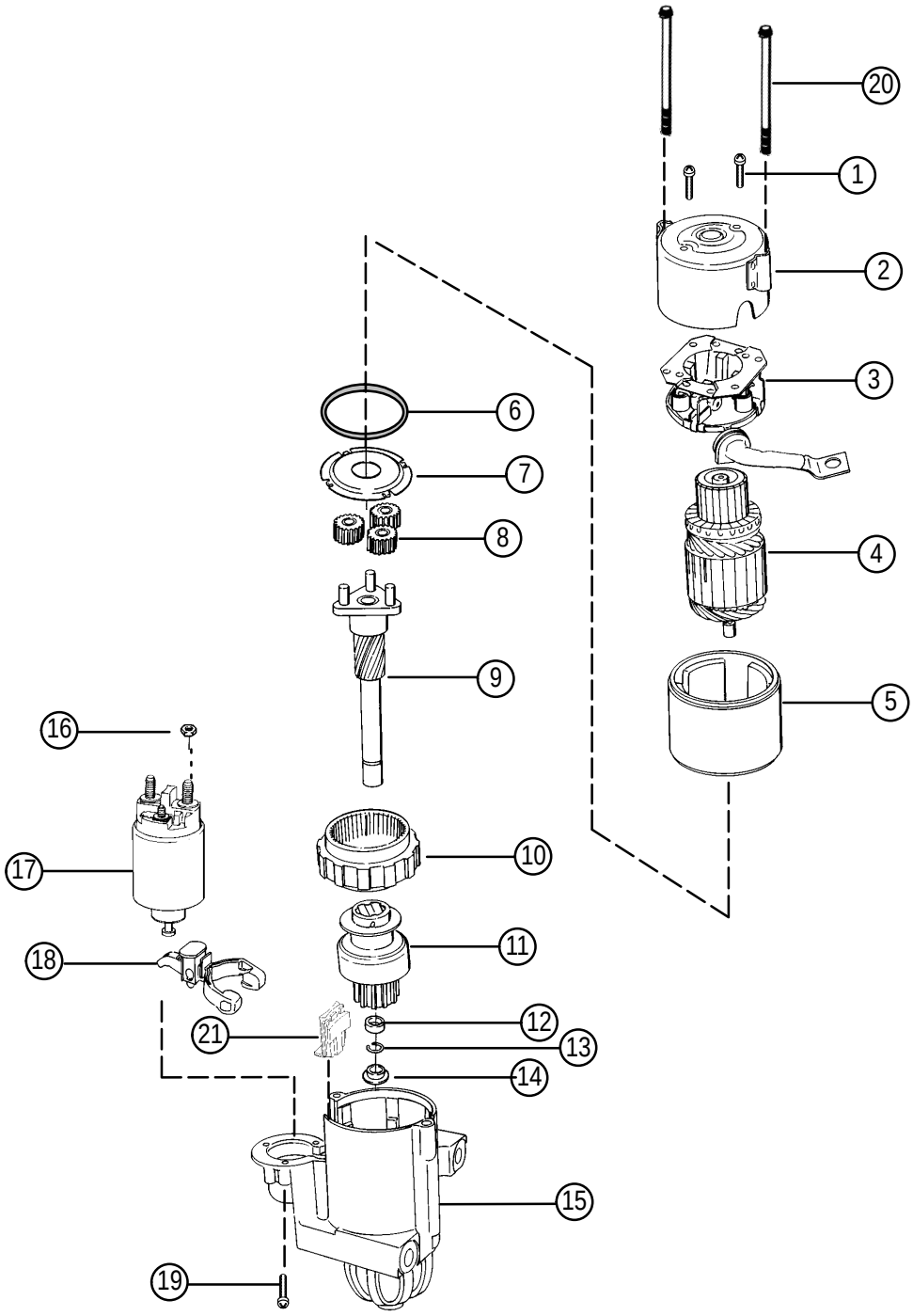
Starting System Components for Delco-Remy Direct Drive Starter (Typical Diagram)



a - Ignition Switch
b - 20 Ampere Fuse
c - Neutral Safety Switch
d - Ground Stud
e - Starter Motor
f - Circuit Breaker
g - Starter Slave Solenoid
h - Wire Junction

Index

PG 260 Starter Motor (Exploded View)

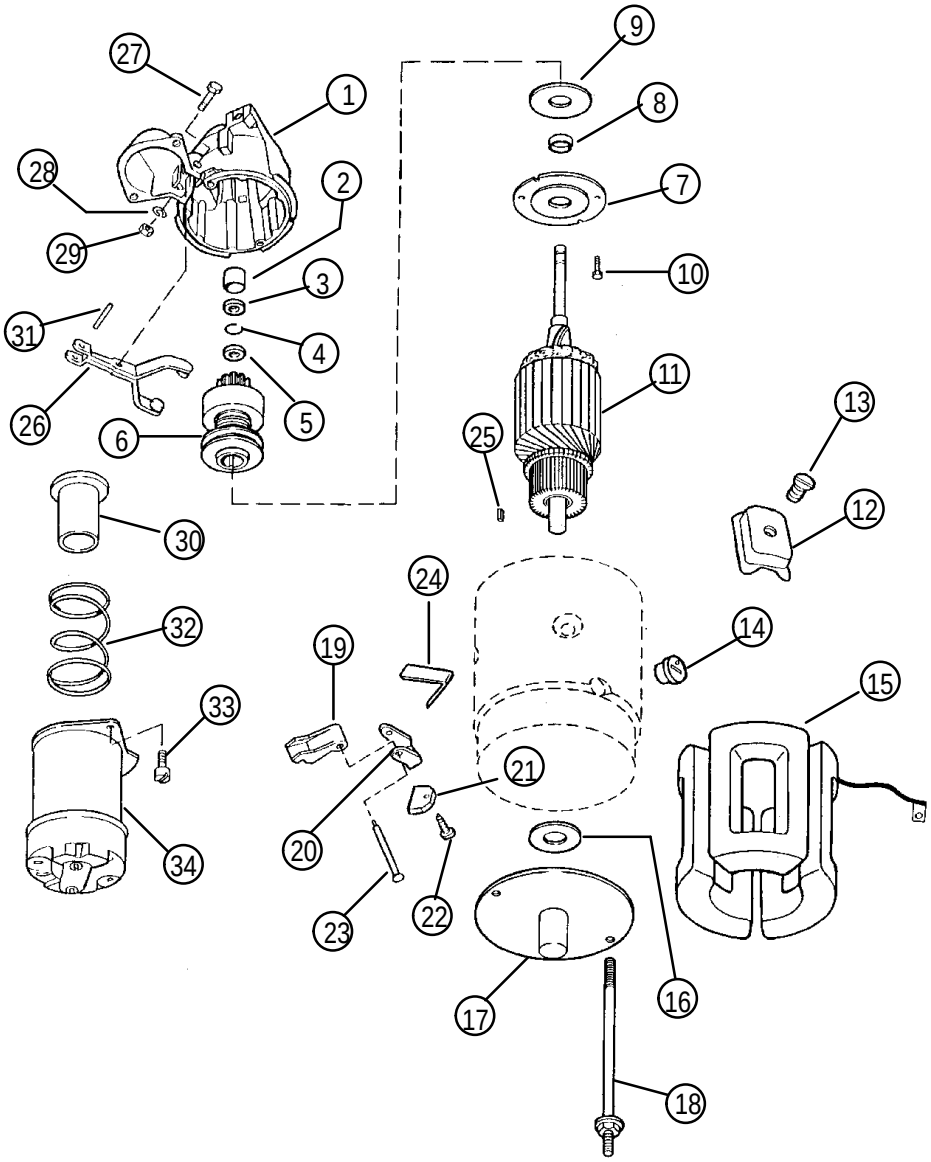


74270

1 - Screw
2 - End Cap
3 - Brushes with Holder
4 - Armature
5 - Field Frame (with Permanent Magnets)
6 - Washer
7 - Shield
8 - Planetary Gears
9 - Shaft
10- Gear
11- Drive

Index

Delco-Remy Starter Motor (Exploded View)



1 - Drive End Housing
2 - Drive End Housing Bushing
3 - Thrust Collar
4 - Retaining Ring - Pinion Stop Collar
5 - Pinion Stop Collar
6 - Clutch Drive Assembly
7 - Bearing Plate
8 - Bearing Plate Bushing
9 - Bearing Plate Washer
10- Bearing Plate Screw
11- Armature
12- Pole Shoe - Field Coil
13- Pole Shoe to Field Coil Screw
14- Field Coil Grommet - Field Frame
15- Field Coil Assembly
16- Leather Washer - Commutator End Frame
17- Lower Commutator End Frame
18- Thru Bolt
19- Insulated Holder - Field Frame Brush

Index

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Maintenance

⚠WARNING

Do not use jumper cables and a booster battery to start engine. Do not recharge a weak battery in the boat. Remove battery and recharge in a ventilated area away from fuel vapors, sparks or flames.

⚠WARNING

Batteries contain acid which can cause severe burns. Avoid contact with skin, eyes and clothing. Batteries also produce hydrogen and oxygen gases when being charged. This explosive gas escapes fill/vent cell caps and may form an explosive atmosphere around the battery for several hours after it has been charged; sparks or flames can ignite the gas and cause an explosion which may shatter the battery and could cause blindness or other serious injury.

Safety glasses and rubber gloves are recommended when handling batteries or filling with electrolyte. Hydrogen gases that escape from the battery during charging are explosive. When charging batteries, be sure battery compartment, or area where battery is located, is well vented. Battery electrolyte is a corrosive acid and should be handled with care. If electrolyte is spilled or splashed on any part of the body, immediately flush the exposed area with liberal amounts of water and obtain medical aid as soon as possible.

⚠CAUTION

To prevent damage to the electrical system be sure to adhere to the following:

- When installing battery, be sure to connect the POSITIVE (+) battery cable to POSITIVE (+) battery terminal first and then the NEGATIVE (–) battery cable to NEGATIVE (–) battery terminal.
- Never disconnect the battery cables while the engine is running.
- If a charger or booster is to be used, be sure to connect it in parallel with existing battery (positive to positive and negative to negative).
- When applying a booster charge to battery, disconnect both cables from battery (to prevent damage to voltage regulator).
- Check battery condition periodically.
- Make sure that battery leads are kept clean and tight.

Testing

⚠CAUTION

Test battery in well ventilated area as gases given off by battery are hazardous.

Place battery under heavy load (as during engine cranking or with a variable resistor tester) and test cell voltage while under load.

Certain conditions must be met before testing.

- Battery must be 60 to 100°F (16 to 38°C).
- Electrolyte level must be correct in all cells.
- Battery must be at least half charged.
- No obvious defects.

1. Check voltage per manufacturer's specifications.
2. If readings are low, recharge and retest.
3. If readings remain low, battery should be replaced.

Storage

1. Remove battery and clean exterior.
2. Check fluid level and fill if low.
3. Cover terminals and bolts with light coat of grease.
4. Set battery on wood or in carton; store in cool, dry place.
5. Check every 20 days for fluid level and slow charge.

IMPORTANT: A discharged battery can be damaged by freezing.

Positive Current Flow

This is a general description of the positive current flow, from the battery and through the system until the starter motor cranks.

- Battery to the solenoid switch (on starter) (RED battery cable).
- Solenoid switch to circuit breaker (RED).
- Circuit breaker to wire junction (RED-PUR).
- Wire junction to wiring harness plug (RED-PUR) terminal 6.
- Wiring harness plug to 20 amp fuse (RED-PUR).
- 20 amp fuse to ignition switch terminal I (RED-PUR). At this point ignition switch is turned to START.
- Ignition switch terminal I to terminal C.
- Ignition switch terminal C to neutral start switch (YEL-RED). NEUTRAL START SWITCH MUST BE AT NEUTRAL POSITION.
- Neutral start switch to wiring harness plug terminal 7 (YEL-RED).
- Wiring harness plug to starter solenoid (small terminal) (YEL-RED). Also ensure that black (small terminal) wire is grounded.
- Starter solenoid is now “closed,” completing circuit between large terminal (RED-PUR) and other large terminal (YEL-RED), causing starter motor to crank.

Description

The Delco PG 200 starter motor features small permanent magnets mounted inside the field frame. These magnets take the place of current-carrying field coils mounted on iron pole pieces. Internal gear reduction, approximately 4 to 1, through planetary gears results in armature speeds in the 7000 RPM range. The armature and drive shaft are mounted on roller or ball bearings in place of bushings. The solenoid switch, plunger, return spring, and shift lever are permanently mounted in the drive housing.

⚠CAUTION

The starter motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor must never be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.

Solenoid Switch

The solenoid switch, along with plunger, return spring, and shift lever, are completely sealed and permanently mount-ed in the drive housing. If solenoid is defective, entire drive housing must be replaced.

Periodic Inspection

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required as follows:

1. Inspect terminals for corrosion and loose connections.
2. Inspect wiring for frayed and worn insulation.
3. Check starter mounting bolts for tightness.

Starter Motor Repair

Removal

⚠WARNING

Disconnect battery cables at battery before removing starter.

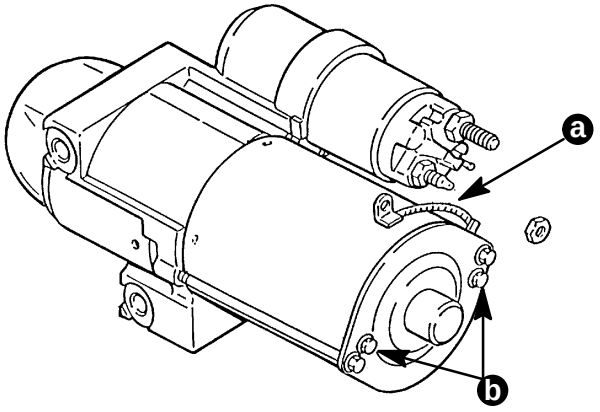
1. Disconnect battery cables from battery.
2. Disconnect wires from solenoid terminals.

IMPORTANT: Some starter motors may use a special mounting shim for gaining flywheel clearance. Do not lose this shim; it will be needed when remounting starter on engine block.

3. Remove starter mounting bolts.
4. Pull starter assembly away from flywheel and remove from engine.

Disassembly

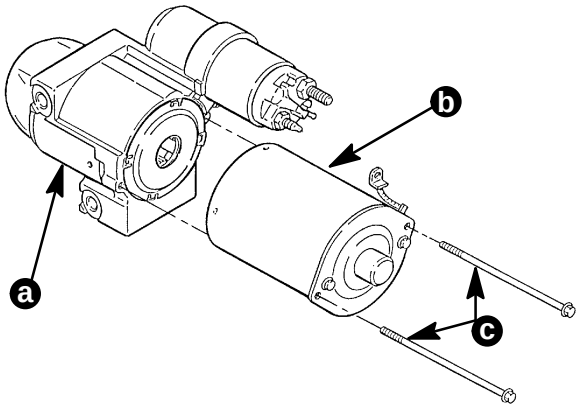
1. Remove brush lead from solenoid and screws from end frame.



72060

a - Brush Lead
b - Screws

2. Remove thru bolts and separate field frame with armature from drive housing.

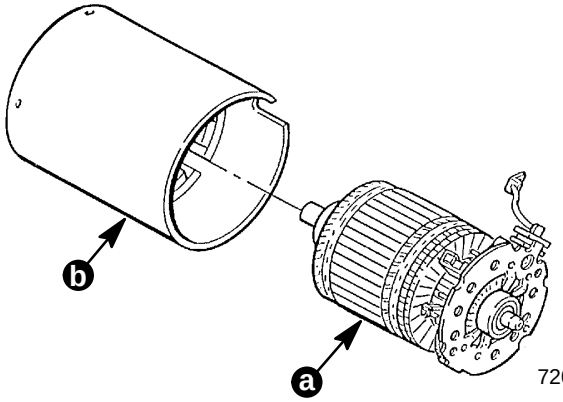


72061

a - Field Frame/Armature
b - Drive Housing
c - Thru Bolts

3. Pull armature out of field frame.

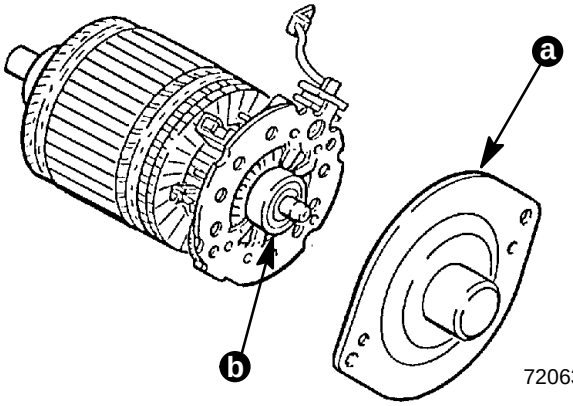
NOTE: Permanent magnets inside field frame will be holding armature in place.



72062

a - Armature
b - Field Frame

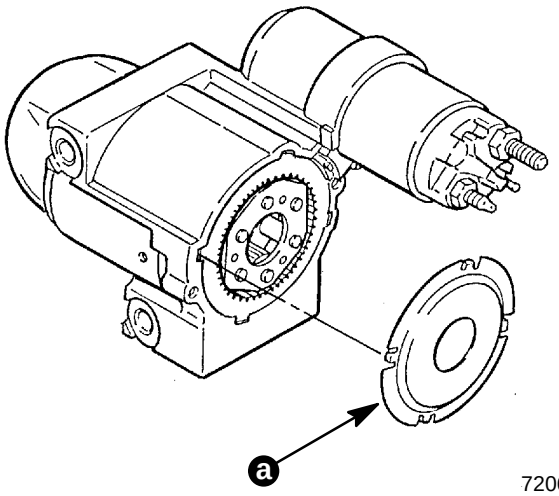
4. Pull end frame off bearing.



72063

a - End Frame
b - Bearing

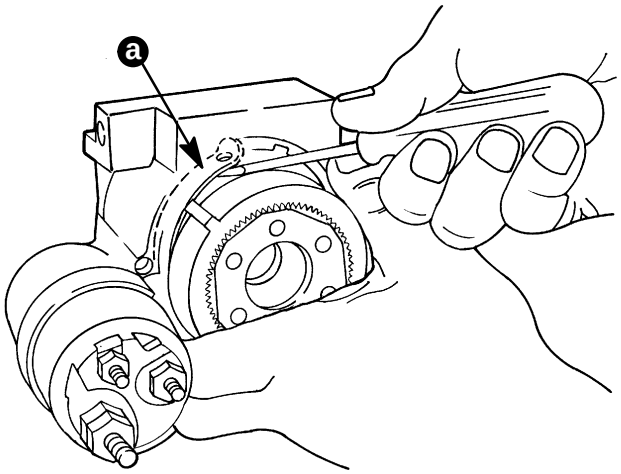
5. Remove shield.



72065

a - Shield

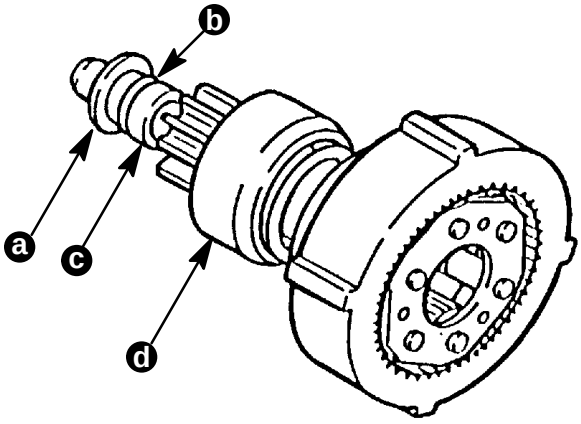
6. Use a screwdriver, as shown, to disengage shift lever from drive.



72064

a - Shift Lever

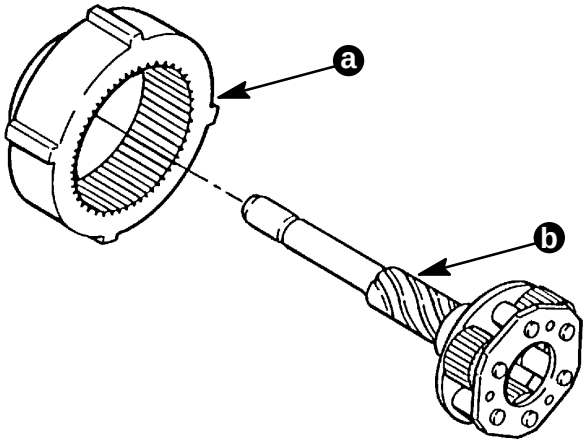
7. Remove thrust collar, retaining ring and collar. Remove drive.



72067

a - Thrust Collar
b - Retaining Ring
c - Collar
d - Drive

8. Remove gear from shaft assembly.



72066

a - Gear
b - Shaft Assembly

Cleaning and Inspection

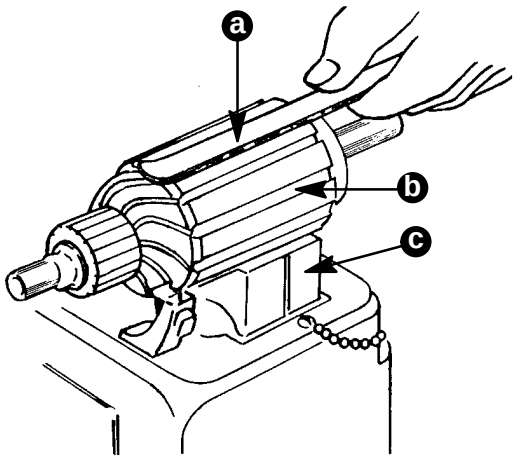
IMPORTANT: Do not use grease dissolving solvents to clean electrical components, planetary gears, or drive. Solvent will damage insulation and wash the lubricant out of the drive and gears. Use clean rags and compressed air to clean components.

1. Test over-running clutch action of drive. Pinion should turn freely in over-running direction and must not slip in cranking direction. Check pinion teeth. Check spring for tension and drive collar for wear. Replace if necessary.
2. Check that brush holders are not damaged or bent and hold brushes against commutator. Check brushes for wear; refer to “Brushes and Brush Holder.”
3. Inspect armature commutator. If badly grooved or out-of-round, turn down and undercut commutator.
4. Inspect all roller bearing surfaces for wear. Check that bearings roll freely. If any roughness is felt, replace bearings.
5. Inspect planetary gear assembly. Gears must mesh easily and roll freely with no binding.

Armature Tests

TEST FOR SHORTS

Check armature for shorts by placing on growler and holding hack saw blade over armature core while rotating armature. If saw blade vibrates, armature is shorted. After cleaning between commutator bars, recheck. If saw blade still vibrates, replace armature.

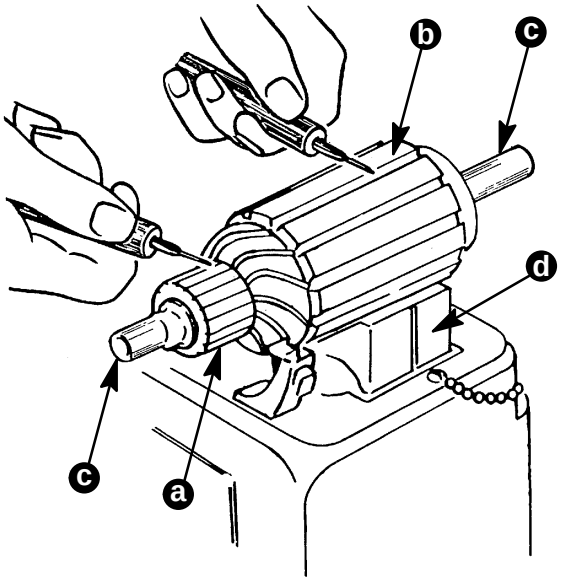


01440

a - Hacksaw Blade
b - Armature Core
c - Growler

TEST FOR GROUND

1. With continuity meter, place one lead on armature core or shaft and other lead on commutator.
2. If meter hand moves, armature is grounded and must be replaced.



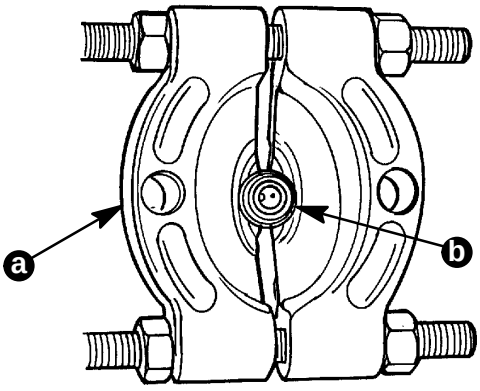
01441

a - Commutator
b - Armature Core
c - Shaft
d - Growler

Armature Bearing (Commutator End)

REMOVAL

Use a universal puller plate, as shown, to remove bearing.



72068

a - Universal Puller Plate
b - Bearing

INSTALLATION

IMPORTANT: Brush holder must be installed on armature before installing armature bearing.

Using the correct size driver, press on inner bearing race until it contacts shoulder of armature shaft.

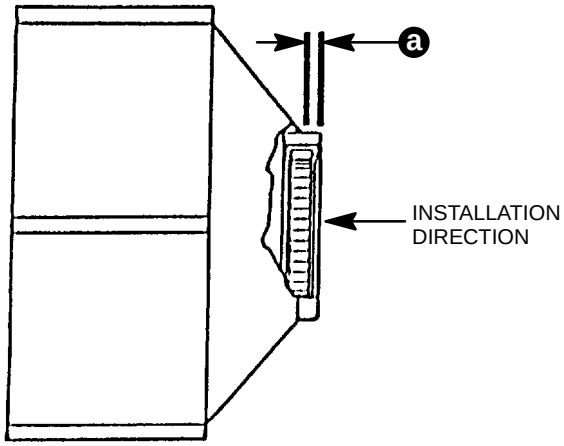
Gear Bearing

REMOVAL

Using the correct size driver, press bearing out of gear.

INSTALLATION

1. Using the correct size driver, press bearing into gear, from direction shown, to depth specified.



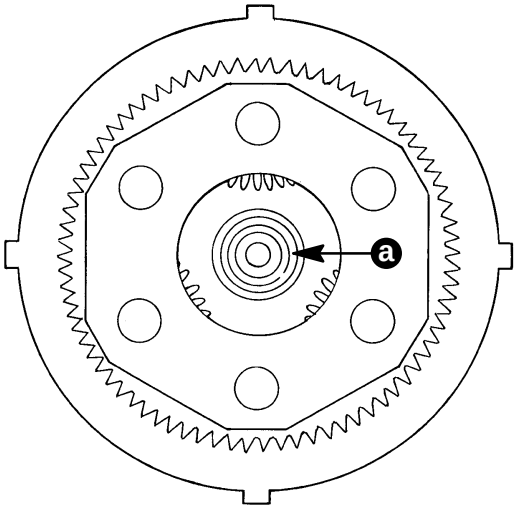
72625

a - Depth - .011 - .014 in (0.28-0.38 mm)

2. Lubricate bearing and gear teeth with a small amount of Quicksilver 2-4-C Marine Lubricant with Teflon.

Shaft Assembly Bearing

IMPORTANT: Roller bearing is not replaceable. If bearing is defective, replace entire shaft assembly. Apply Quicksilver 2-4-C Marine Lubricant with Teflon to bearing before starter reassembly.



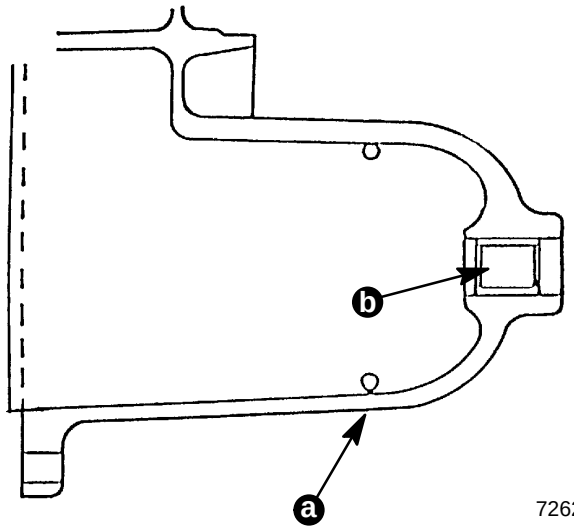
72070

a - Roller Bearing

Drive End Housing Bearing

REMOVAL

Using the correct size driver, press bearing out of housing.

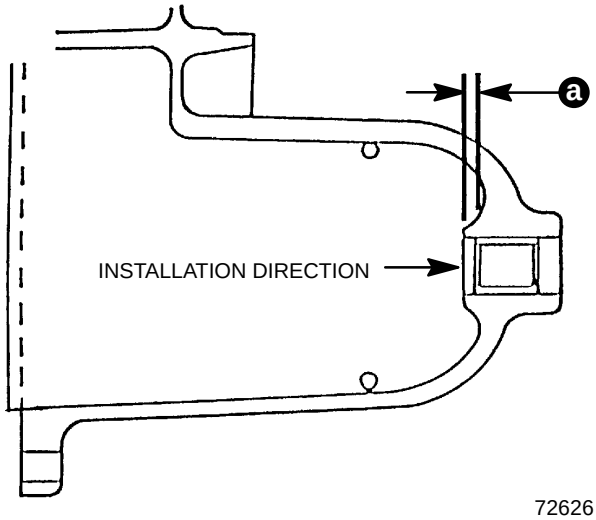


72626

a - Drive End Housing
b - Bearing

INSTALLATION

1. Using the correct size driver, press bearing into housing, from direction shown, to depth specified.



72626

a - Depth - .009-.017 in. (0.25-0.45 mm)

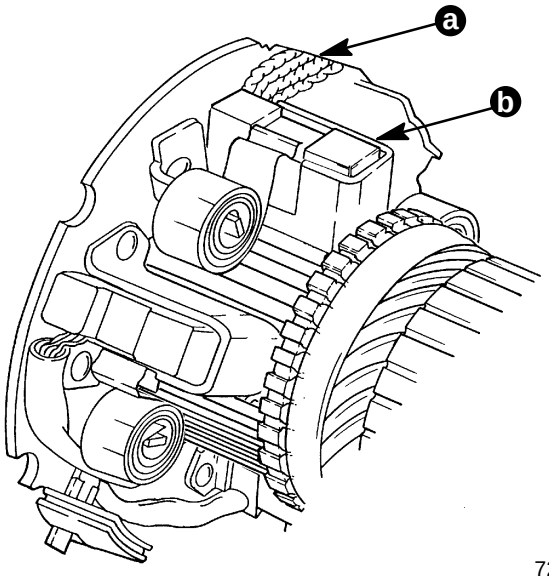
2. Lubricate bearing with a small amount of Quicksilver 2-4-C Marine Lubricant.

Brushes and Brush Holder

INSPECTION

Replace brushes and holder when brush leads are touching guide.

Make sure brushes move freely in guides.



72069

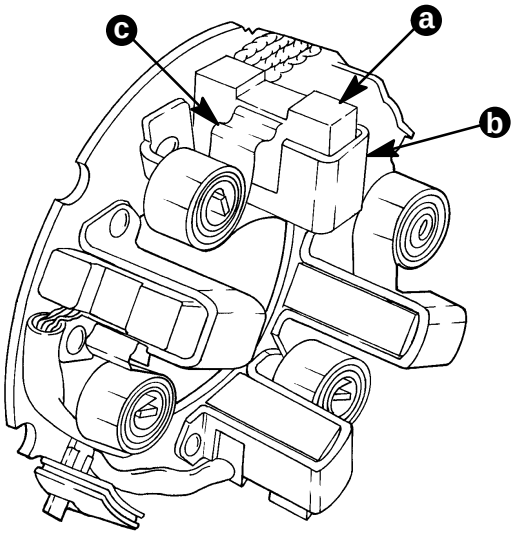
a - Brush Leads
b - Guide

REMOVAL

1. Remove armature bearing as previously described.
2. Remove brush holder.

INSTALLATION

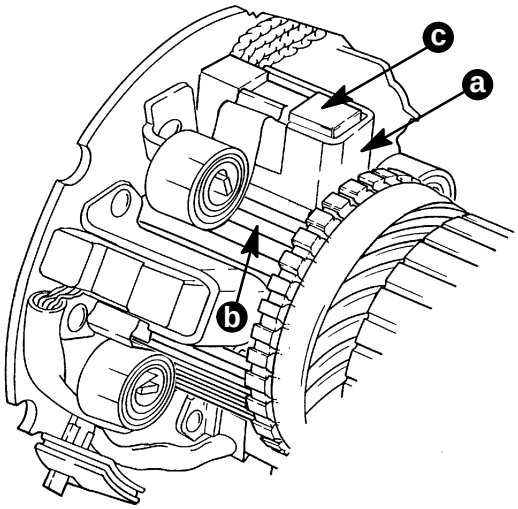
1. Push each brush up into its guide to allow spring to hold it in place, as shown.



72072

a - Brush
b - Guide
c - Brush Spring

2. Place brush holder on armature and push brushes down against commutator, as shown.



72069

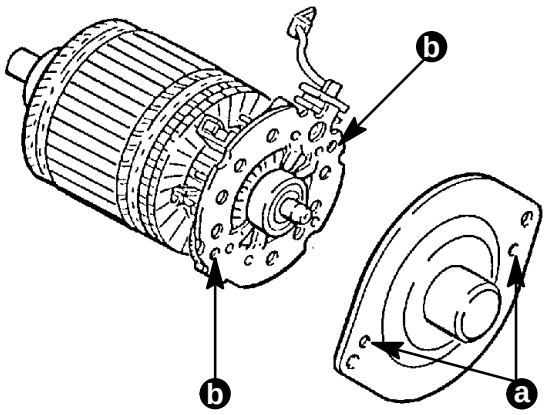
a - Brush Holder
b - Commutator
c - Brush

3. Install armature bearing as previously described.

Index

Reassembly

1. Install end frame on brush holder. Align holes of end frame with holes of brush holder. Tighten screws securely.

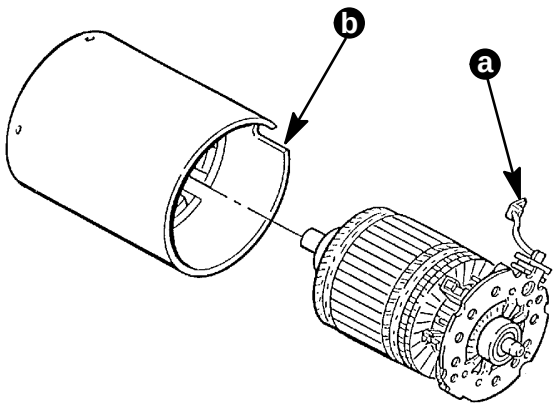


72063

a - Holes of End Frame
b - Holes of Brush Holder

2. Insert armature into field frame. Align brush holder lead with notch in field frame.

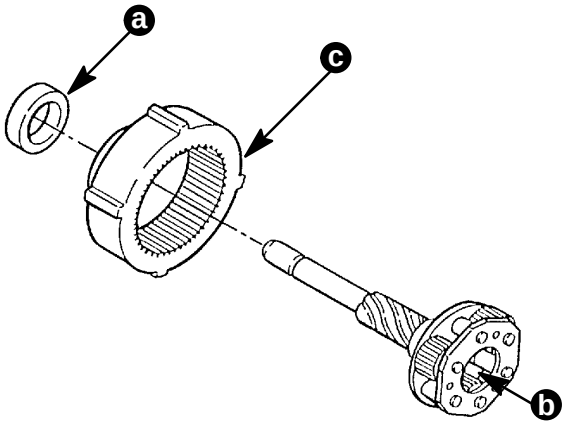
NOTE: Permanent magnets in field frame will pull armature in place.



72062

a - Brush Holder Lead
b - Notch

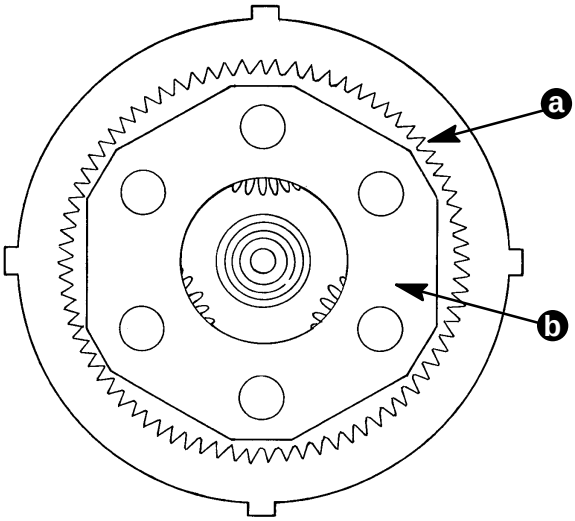
3. Coat roller bearings and gear with a small amount of Quicksilver 2-4-C Marine Lubricant.



72627

a - Roller Bearing
b - Roller Bearing
c - Gear

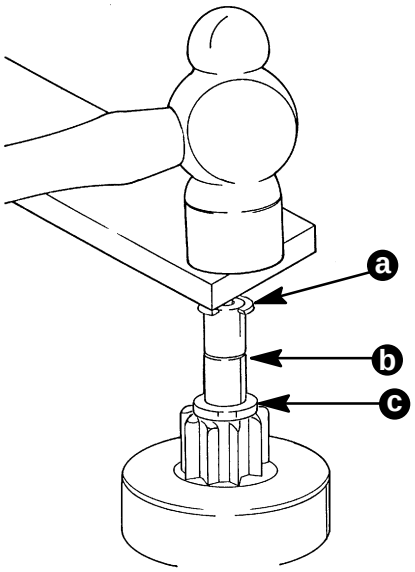
4. Assemble gear and shaft together, as shown.



72070

a - Gear Assembly
b - Shaft Assembly

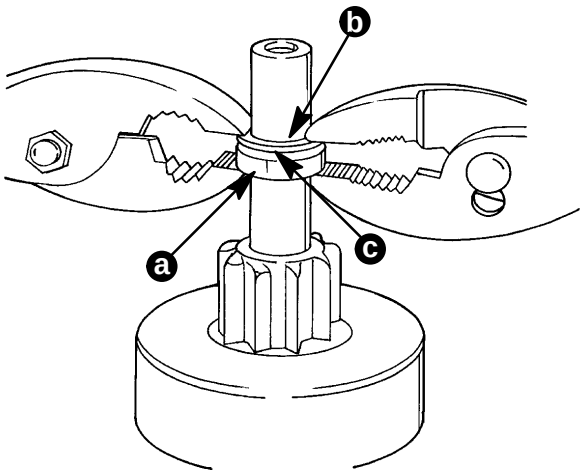
5. Assemble drive on shaft assembly as follows:
   a. Lubricate drive end of shaft assembly with SAE 10W oil.
   b. Slide drive assembly onto shaft with pinion outward.
   c. Slide retainer onto shaft with cupped surface facing end of shaft (away from pinion).
   d. Position snap ring on upper end of shaft and hold in place with block of wood. Strike wood block with hammer, thus forcing snap ring over end of shaft. Slide snap ring down into groove.



72073

a - Snap Ring
b - Groove
c - Retainer

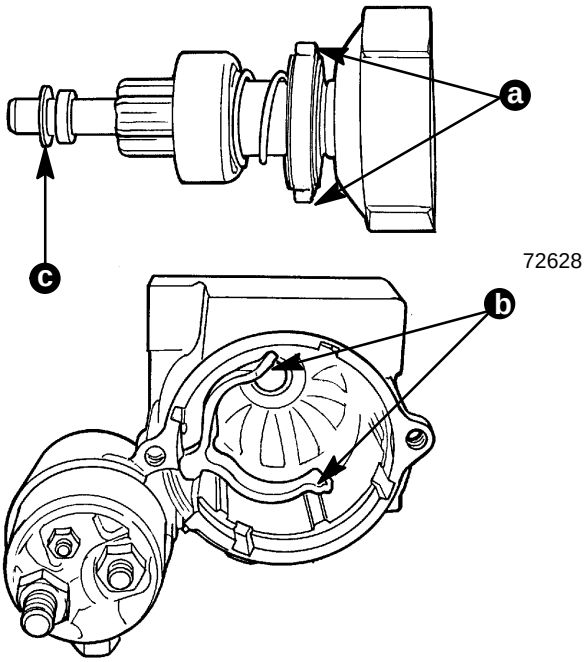
   e. Assemble thrust collar on shaft with shoulder next to snap ring.
   f. Position retainer and thrust collar next to snap ring. Then, using two pliers, grip retainer and thrust collar and squeeze until snap ring is forced into retainer.



72074

a - Retainer
b - Thrust Collar
c - Snap Ring

6. Apply a thin coating of Quicksilver 2-4-C Marine Lubricant with Teflon to roller bearing in drive housing.
7. Insert shaft and drive assembly into drive housing. Pins of drive must be snapped into holes of shift lever. Thrust collar must be in place before shaft is inserted in housing roller bearing.

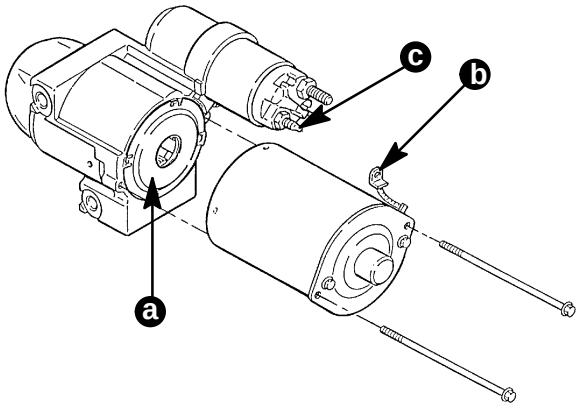


72628

72075

a - Pins of Drive
b - Holes of Shift Lever
c - Thrust Collar

8. Install shield. Align brush lead and solenoid terminal when inserting armature into planetary gears.

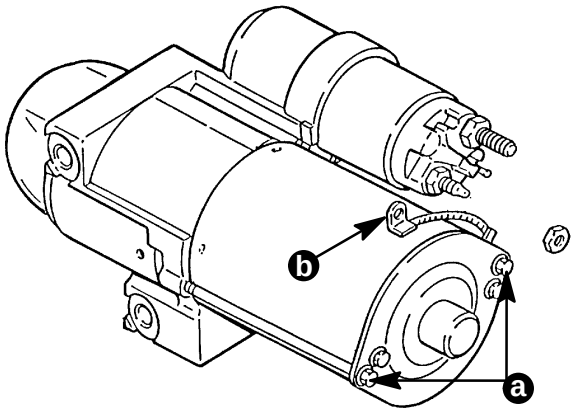


72061

a - Shield
b - Brush Lead
c - Solenoid Terminal

9. Install thru bolts and brush lead. Tighten fasteners securely.

IMPORTANT: Do not overtighten thru bolts. Overtightening will bend end frame.



72060

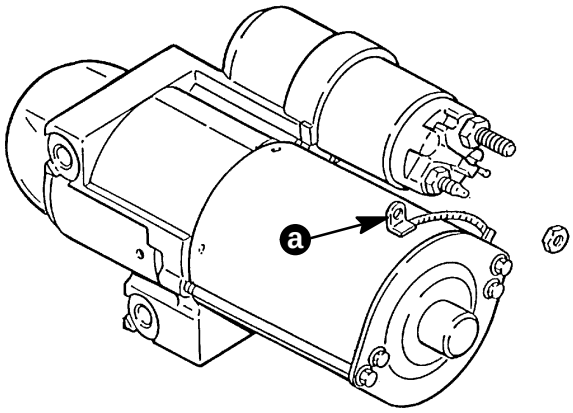
a - Thru Bolts
b - Brush Lead

Clearances

PINION CLEARANCE

Pinion clearance must be checked after reassembly of starter motor.

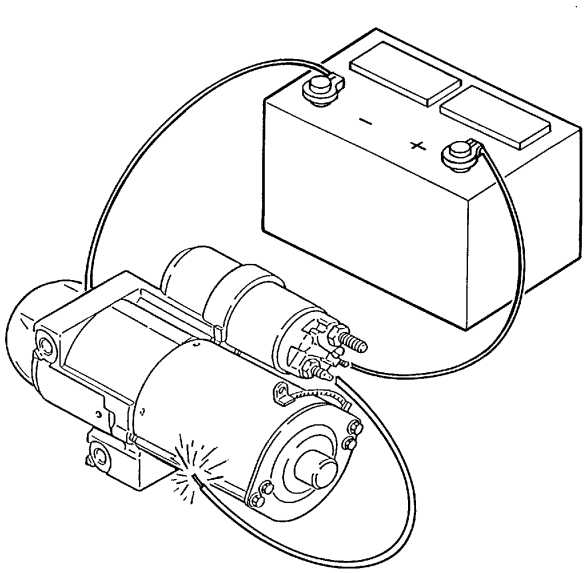
1. Disconnect brush lead from solenoid motor terminal M and insulate it carefully.



72060

a - Brush Lead

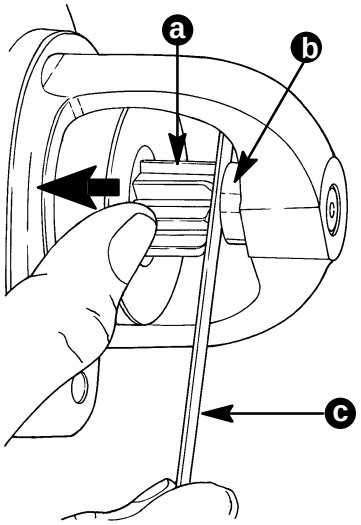
2. Connect 12 volt battery positive (+) lead to solenoid switch terminal and negative (–) lead to solenoid frame.
3. Momentarily touch a jumper lead from solenoid motor terminal M to starter motor frame. This shifts pinion into cranking position where it will remain until battery is disconnected.



72629

4. Push pinion back toward comm end to eliminate slack.

5. Measure distance between pinion and pinion retainer.
6. If clearance is not within limits of .010-.160 in. (0.25-4.00 mm), it may indicate excessive wear of solenoid linkage, shift lever yoke buttons, or improper assembly of shift lever mechanism. Replace worn or defective parts, since no provision is made for adjusting pinion clearance.



72077

a - Pinion
b - Retainer
c - Feeler Gauge

Installation

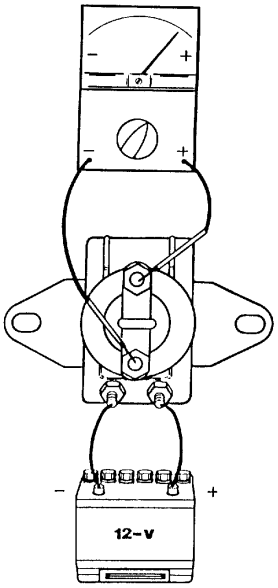
IMPORTANT: Install special mounting shim (if equipped) between starter motor and engine block.

1. Place starter motor in position and install mounting bolts. Torque bolts to 30 lb. ft. (41 N•m).
2. Connect YELLOW/RED wire to terminal S of solenoid. Connect ORANGE wire, RED wire, and battery cable to large terminal of solenoid. Tighten fasteners securely. Coat terminals with Quicksilver Liquid Neoprene. Install battery cable boot, if so equipped.
3. Connect battery cables to battery in the following order. Connect positive (+) cable to positive (+) battery terminal and tighten cable clamp. Then connect negative (–) cable to negative (–) terminal and tighten clamp.

Standard Starter Slave Solenoid

Testing/Replacement

1. Using continuity meter, connect test leads as shown, and connect 12 volt battery with jumper leads as shown.



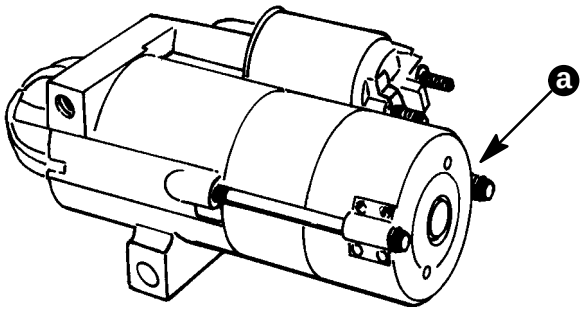
72630

2. If no meter movement is present, replace solenoid.

Delco PG 260

Identification

The starter identification number is located as shown.



Permanent Magnet Gear Reduction (PG260) Starter Motor

a - Starter Identification Number

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Maintenance

⚠WARNING

DO NOT use jumper cables and a booster battery to start engine. DO NOT recharge a weak battery in the boat. Remove battery and recharge in a well ventilated area away from fuel vapors, sparks or flames.

⚠WARNING

Batteries contain acid which can cause severe burns. Avoid contact with skin, eyes and clothing. Batteries also produce hydrogen and oxygen gases when being charged. This explosive gas escapes fill/vent caps and may form an explosive atmosphere around the battery for several hours after it has been charged; sparks or flames can ignite the gas and cause an explosion which may shatter the battery and could cause blindness or other serious injury.

Safety glasses and rubber gloves are recommended when handling batteries or filling electrolyte. Hydrogen gases that escape from the battery during charging are explosive. When charging batteries, be sure battery compartment, or area where batteries are located, is well vented. Battery electrolyte is a corrosive acid and should be handled with care. If electrolyte is spilled or splashed on any part of the body, immediately flush the exposed area with liberal amounts of water and obtain medical aid as soon as possible.

Solenoid Switch

The solenoid switch can be removed and replaced if defective.

Periodic Inspection

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required as follows:

1. Inspect terminals for corrosion and loose connections.
2. Inspect wiring for frayed and worn insulation.
3. Check starter mounting bolts for tightness.

Starter Motor Repair

Removal

⚠WARNING

Disconnect battery cables at battery before removing starter.

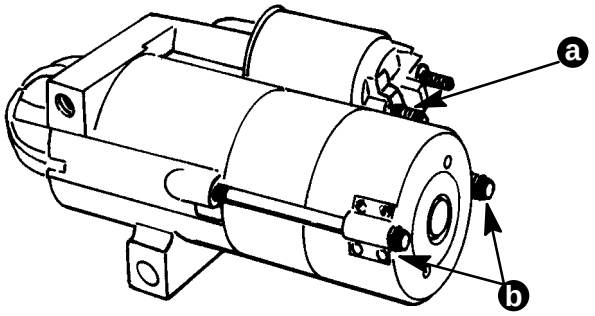
1. Disconnect battery cables from battery.
2. Disconnect wires from solenoid terminals.

IMPORTANT: Some starter motors may use a special mounting shim for gaining flywheel clearance. Do not lose this shim; it will be needed when remounting starter on engine block.

3. Remove starter mounting bolts.
4. Pull starter assembly away from flywheel and remove from engine.

Disassembly

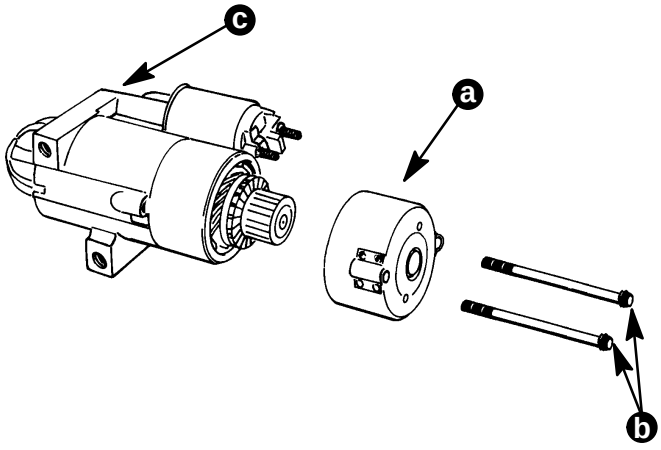
1. Remove brush lead from solenoid and screws from end frame.



74041

a - Brush Lead
b - Screws

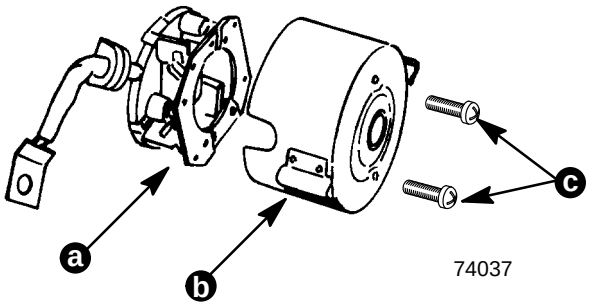
2. Remove thru bolts and separate end frame from field frame and end cap.



74040

a - End Cap
b - Thru Bolt
c - Drive Housing

3. Remove brush holder from end cap.

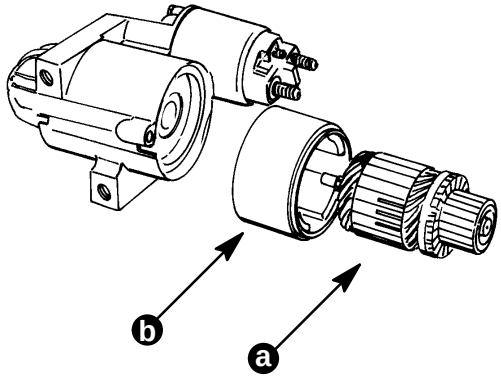


74037

a - Brush Holder
b - End Cap
c - Screws (2)

4. Remove armature and field frame from drive housing.
5. Pull armature out of field frame.

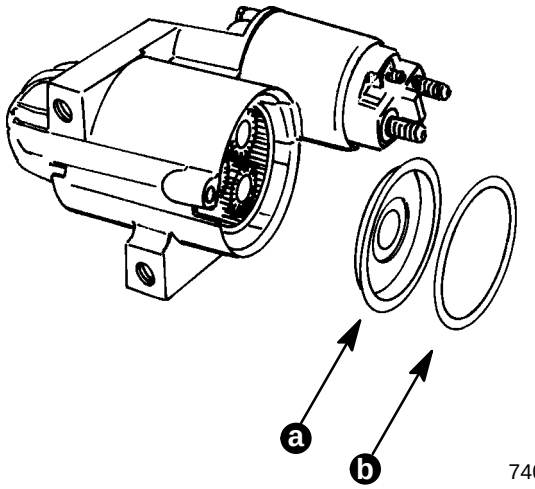
NOTE: Permanent magnets inside field frame will be holding armature in place.



74086

a - Armature
b - Field Frame

6. Remove shield and washer.

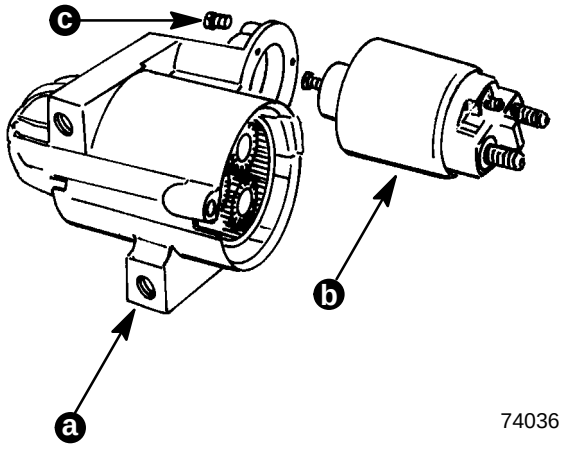


74038

a - Shield
b - Washer

Index

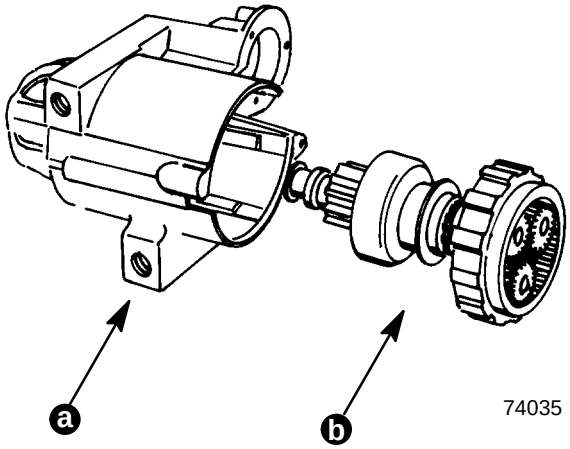
7. Remove the three screws retaining the solenoid. Remove solenoid from drive housing.



74036

a - Drive Housing
b - Solenoid
c - Screws (3)

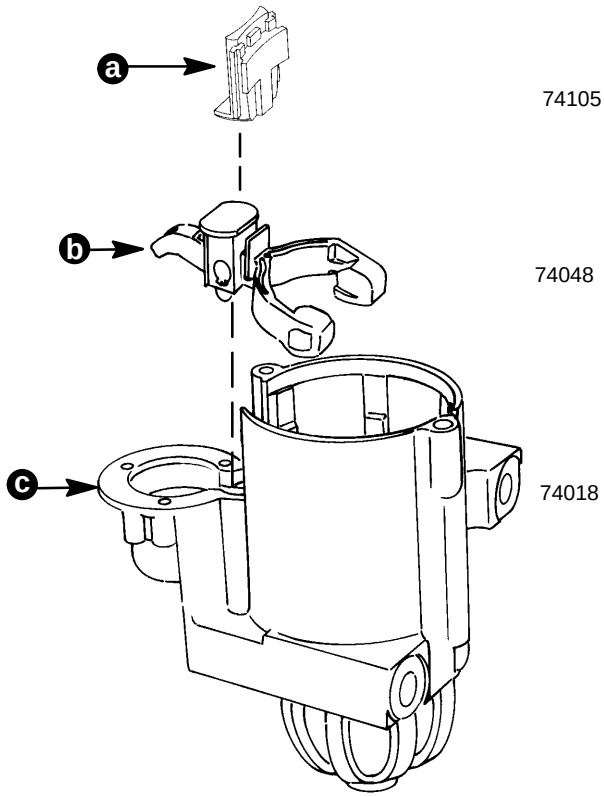
8. Remove drive and associated parts from drive housing.



74035

a - Drive Housing
b - Drive

9. Remove solenoid arm and rubber grommet from the drive housing.



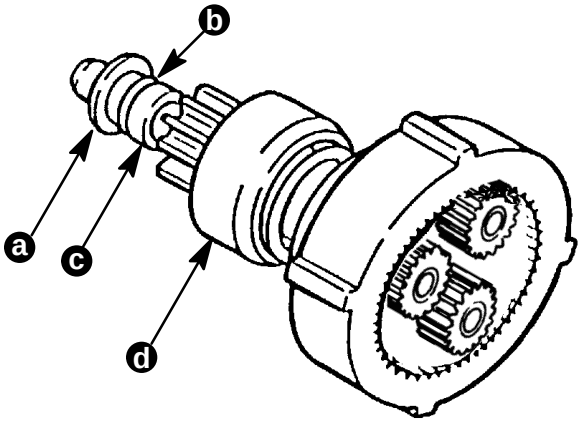
74105

74048

74018

a - Rubber Grommet
b - Solenoid
c - Drive Housing

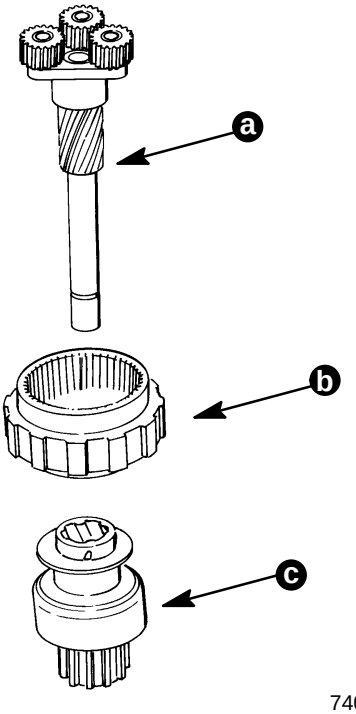
10. Remove thrust collar, retaining ring and collar from planetary shaft.



74016

a - Thrust Collar
b - Retaining Ring
c - Collar
d - Drive

11. Remove drive and gear from planetary shaft.



74087

e - Gear
f - Shaft Assembly
g - Drive

Cleaning and Inspection

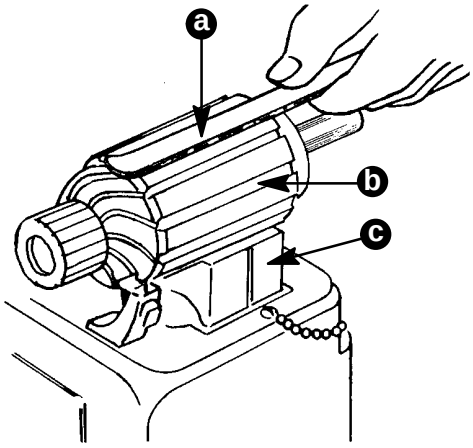
IMPORTANT: Do not use grease dissolving solvents to clean electrical components, planetary gears, or drive. Solvent will damage insulation and wash the lubricant out of the drive and gears. Use clean rags and compressed air to clean components.

1. Test over-running clutch action of drive. Pinion should turn freely in over-running direction and must not slip in cranking direction. Check pinion teeth. Check spring for tension and drive collar for wear. Replace if necessary.
2. Check that brush holders are not damaged or bent and hold brushes against commutator. Check brushes for wear; refer to “Brushes and Brush Holder.”
3. Inspect armature commutator. If badly grooved or out-of-round, turn down and undercut commutator.
4. Inspect all roller bearing surfaces for wear. Check that bearings roll freely. If any roughness is felt, replace bearings.
5. Inspect planetary gear assembly. Gears must mesh easily and roll freely with no binding.

Armature Tests

TEST FOR SHORTS

Check armature for shorts by placing on growler and holding hack saw blade over armature core while rotating armature. If saw blade vibrates, armature is shorted. After cleaning between commutator bars, recheck. If saw blade still vibrates, replace armature.

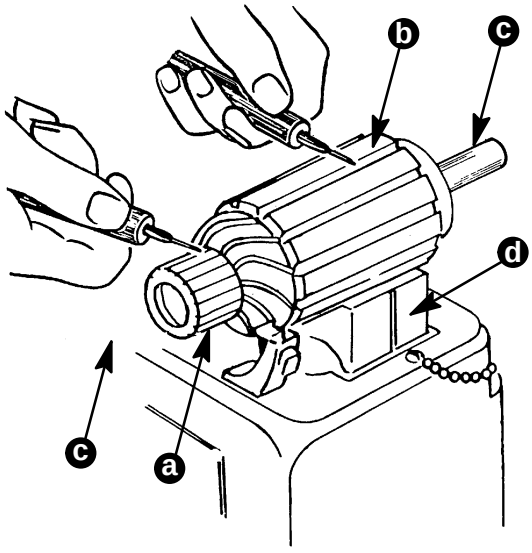


01440

a - Hacksaw Blade
b - Armature Core
c - Growler

TEST FOR GROUND

1. With continuity meter, place one lead on armature core or shaft and other lead on commutator.
2. If meter hand moves, armature is grounded and must be replaced.



01441

a - Commutator
b - Armature Core
c - Shaft
d - Growler

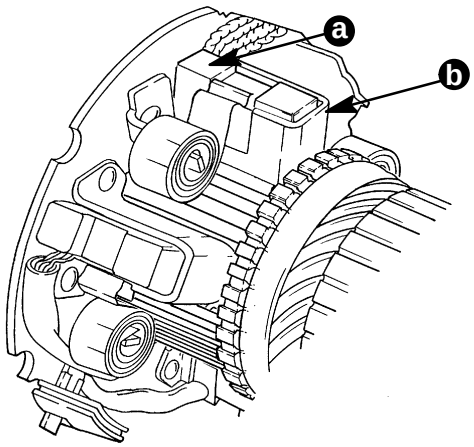
Index

Brushes and Brush Holder

INSPECTION

Replace brushes and holder when brush leads are touching guide.

Make sure brushes move freely in guides.

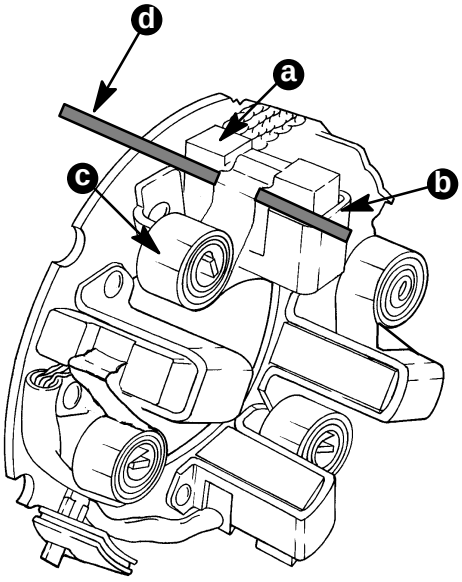


72069

a - Brush Leads
b - Guide

INSTALLATION

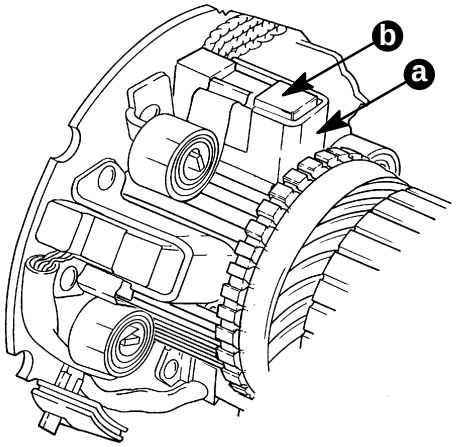
1. Push each brush up into its guide, use a 3 inch piece of coat hanger wire or similar stiff wire to retain the spring while installing armature, as shown.



72069

a - Brush
b - Guide
c - Brush Spring
d - 3-Inch Piece of Coat Hanger or Similar Still Wire

2. Place brush holder on armature and remove pieces of wires from brush holder.

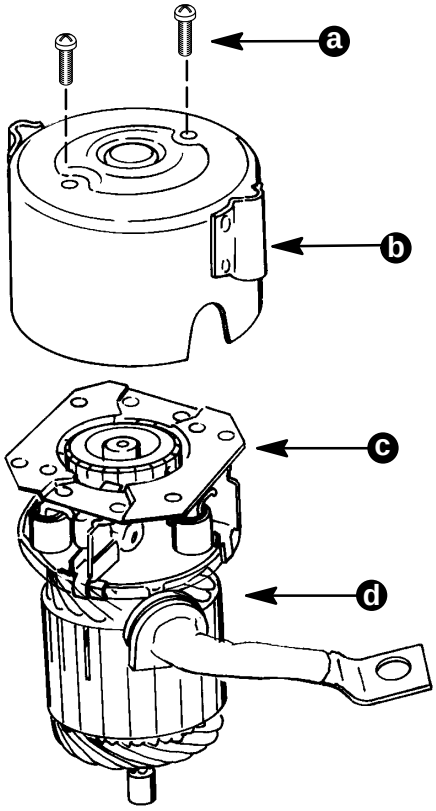


72069

a - Brush Holder
b - Brush

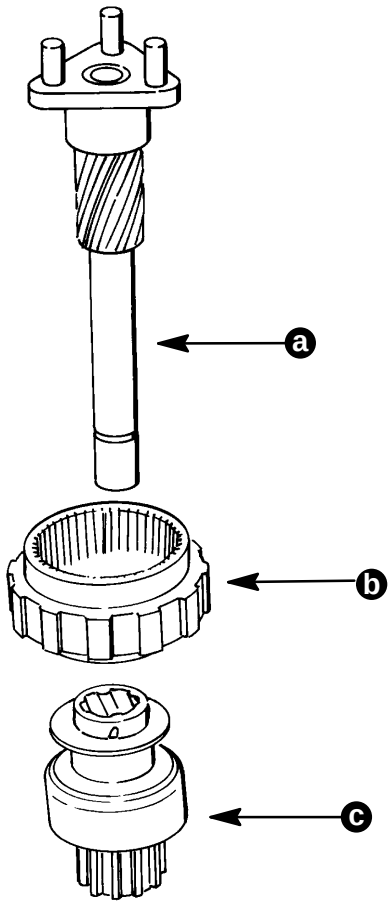
Reassembly

1. Install end frame on brush holder. Align holes of end frame with holes of brush holder. Tighten screws securely.



a - Screw (2)
b - End Cap
c - Brush Holder
d - Armature

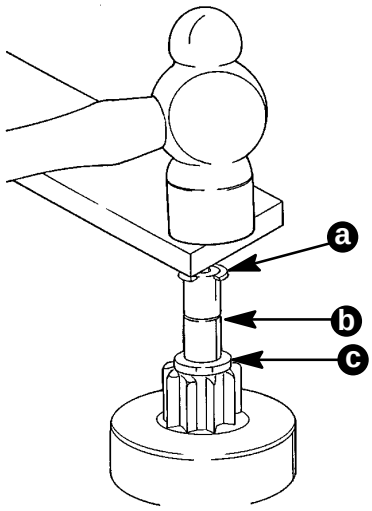
2. Install gear and drive over planetary shaft.



74087

a - Planetary Shaft
b - Gear
c - Drive

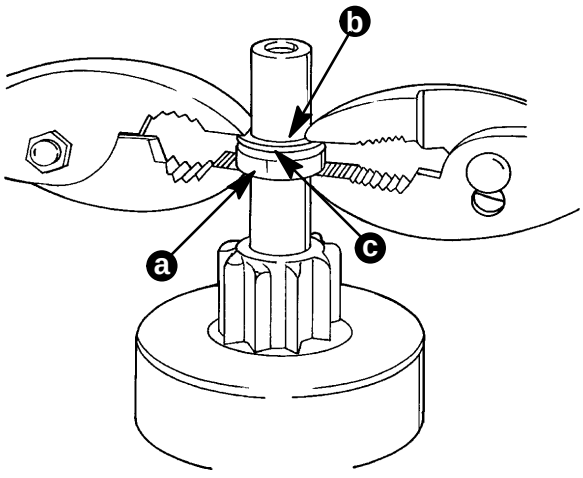
3. Assemble drive on shaft assembly as follows:
   a. Lubricate drive end of shaft assembly with SAE 10W oil.
   b. Place gear over shaft.
   c. Slide drive assembly onto shaft with pinion facing outward.
   d. Slide retainer onto shaft with cupped surface facing end of shaft (away from pinion).
   e. Position snap ring on upper end of shaft and hold in place with block of wood. Strike wood block with hammer, thus forcing snap ring over end of shaft. Slide snap ring down into groove.



72073

a - Snap Ring
b - Groove
c - Retainer

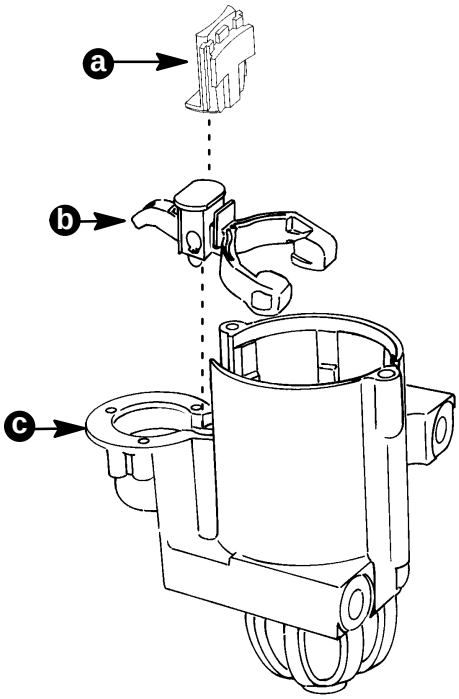
   f. Assemble thrust collar on shaft with shoulder next to snap ring.
   g. Position retainer and thrust collar next to snap ring. Then, using two pliers, grip retainer and thrust collar and squeeze until snap ring is forced into retainer.



72074

a - Retainer
b - Thrust Collar
c - Snap Ring

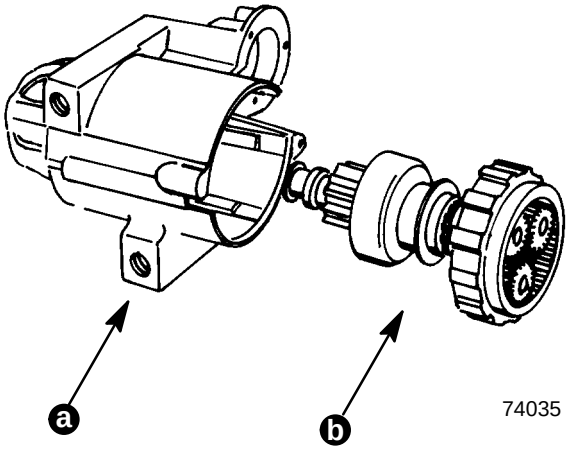
4. Install the planetary gears on planetary shaft.
5. Install solenoid arm and rubber grommet in the drive housing.



74135

a - Rubber Grommet
b - Solenoid
c - Drive Housing

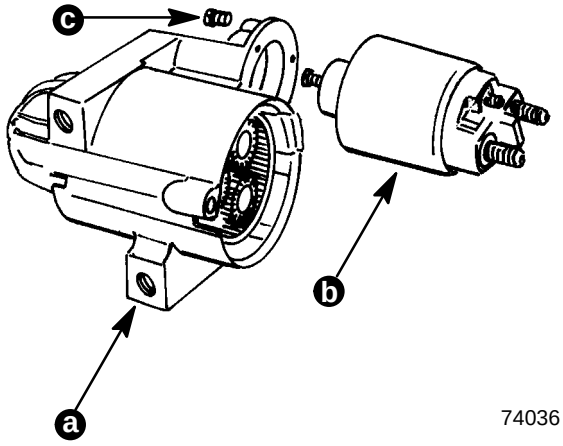
6. Install drive and associated parts in drive housing.



74035

a - Drive Housing
b - Drive

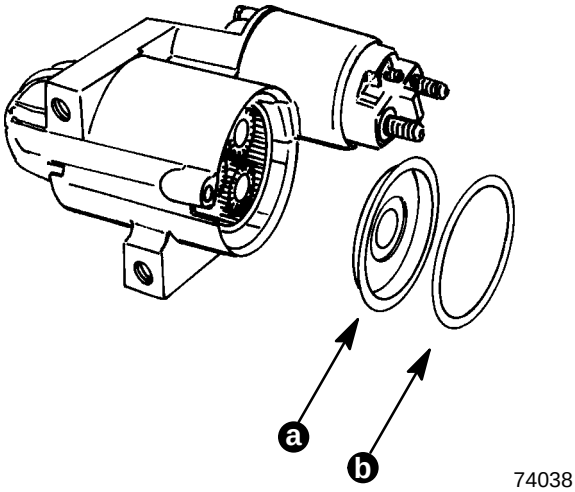
7. Place solenoid in drive housing and tighten screws.



74036

a - Drive Housing
b - Solenoid
c - Screws (3)

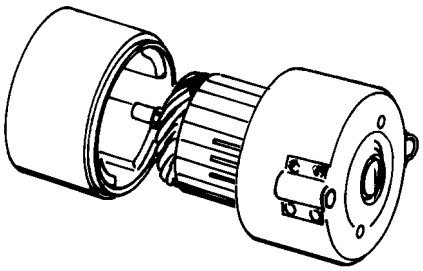
8. Install shield and washer in drive housing.



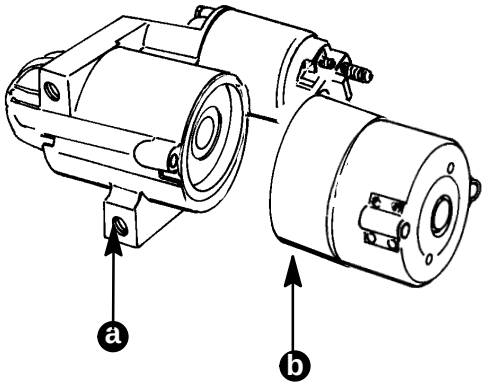
74038

a - Shield
b - Washer

9. Install field frame and armature in drive housing. Align slot in end cap and field frame for proper positioning of rubber grommet. Rotate and align gears and rubber gasket with slot in armature



10. Install field frame and end cap in drive housing align slots in field frame with recess in drive housing.



a - Drive Housing
b - End Cap and Field Frame

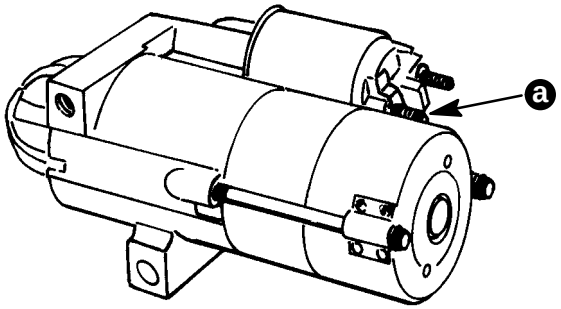
11. Install thru bolts and brush lead. Tighten fasteners securely.

Clearances

PINION CLEARANCE

Pinion clearance must be checked after reassembly of starter motor.

1. Disconnect brush lead from solenoid motor and insulate it carefully.

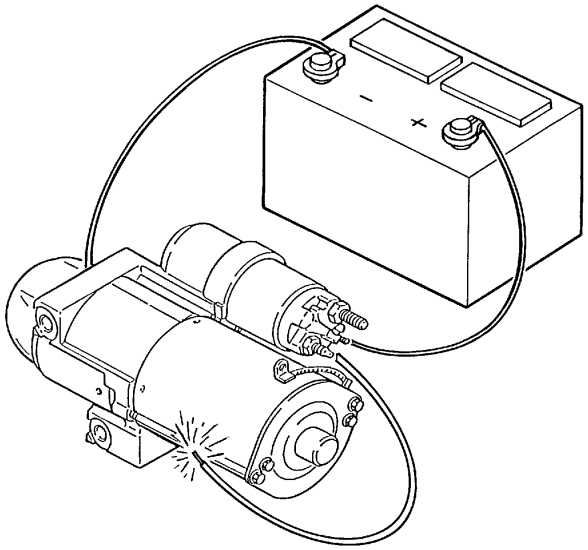


74041

a - Brush Lead

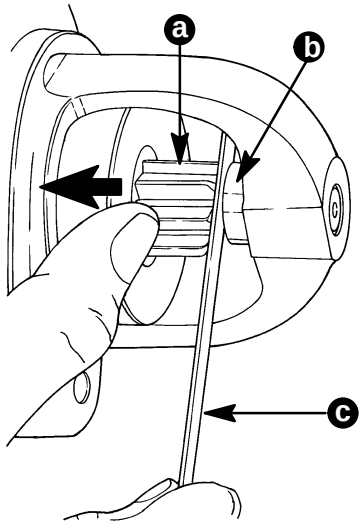
2. Connect 12 volt battery positive (+) lead to battery terminal and negative (–) lead to frame.

3. Momentarily touch a jumper lead from battery terminal to switch terminal. This shifts pinion into cranking position where it will remain until battery is disconnected.



72629

4. Push pinion back toward commutator end to eliminate slack.
5. Measure distance between pinion and pinion retainer.
6. If clearance is not within limits of .010-.160 in. (0.25-4.00 mm), it may indicate excessive wear of solenoid linkage, shift lever yoke, or improper assembly of shift lever mechanism. Replace worn or defective parts, since no provision is made for adjusting pinion clearance.



72077

a - Pinion
b - Retainer
c - Feeler Gauges

Installation

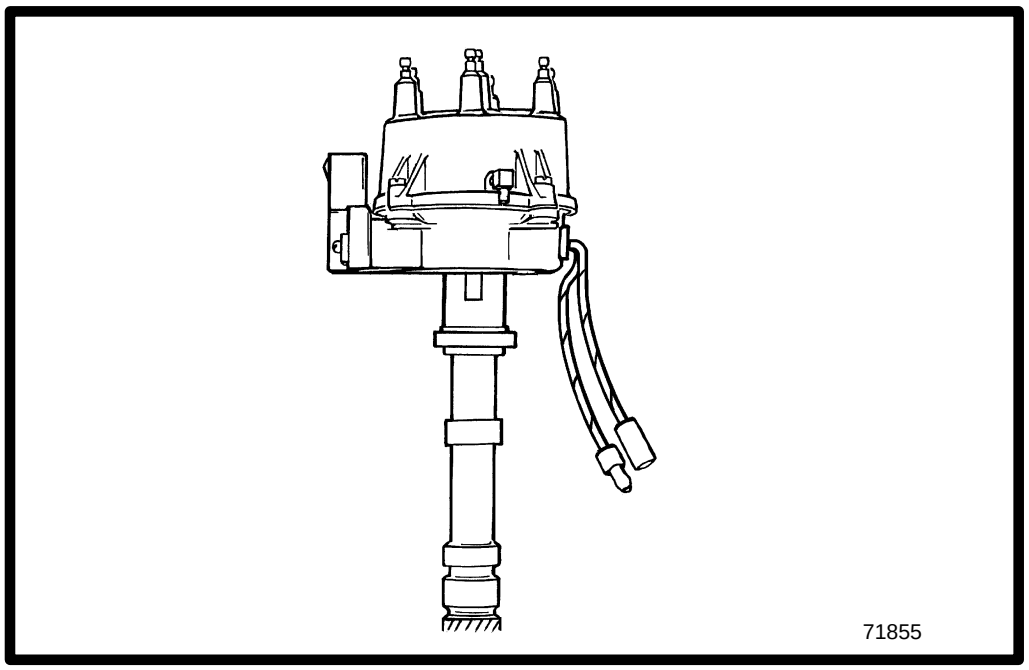
IMPORTANT: Install special mounting shim (if equipped) between starter motor and engine block.

1. Place starter motor in position and install mounting bolts. Torque bolts to 30 lb. ft. (41 N·m).
2. Connect YELLOW/RED wire to terminal S of solenoid. Connect ORANGE wire, RED wire, and battery cable to large terminal of solenoid. Tighten fasteners securely. Coat terminals with Quicksilver Liquid Neoprene. Install battery cable boot, if so equipped.
3. Connect battery cables to battery in the following order. Connect positive (+) cable to positive (+) battery terminal and tighten cable clamp. Then connect negative (–) cable to negative (–) terminal and tighten clamp.

ELECTRICAL SYSTEMS

4

B



IGNITION SYSTEM

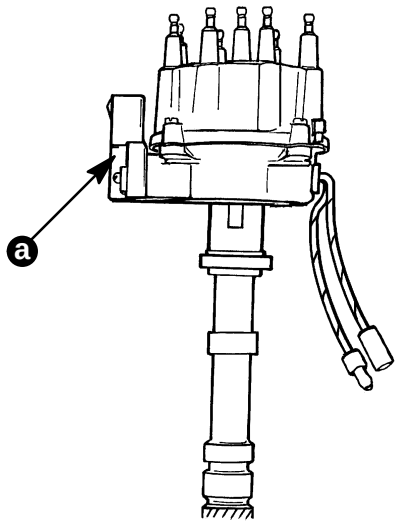
Index

Table of Contents

	Page
Thunderbolt IV (HEI) Ignition System	4B-1
Special Tools	4B-1
Torque Specifications	4B-1
Lubricants, Sealers and Adhesives	4B-1
Coil Specifications	4B-1
Exploded View for Thunderbolt IV Distributor For V-6 Engines	4B-2
MCM V-6 262 CID (4.3L) with Thunderbolt IV	4B-3
Replacement Parts Warning	4B-4
Spark Plugs	4B-4
Firing Order	4B-4
Distributor Advance Curves	4B-4
Repair	4B-4
Precautions	4B-4
Distributor Cap	4B-5
Rotor/Sensor Wheel	4B-5
Sensor	4B-6
Spark Plugs	4B-7
Ignition Module	4B-8
Spark Plug Wires	4B-8
Distributor Repair	4B-8
Removal	4B-8
Disassembly	4B-8
Reassembly	4B-9
Distributor Installation	4B-9
Engine Not Disturbed	4B-9
Engine Disturbed	4B-10
Ignition Timing	4B-10
Thunderbolt V Ignition System	4B-11
Identification	4B-11
General Description	4B-12
Idle Speed Spark Control	4B-12
Acceleration Spark Advance	4B-12
Mean-Best-Timing (MBT) Spark Advance	4B-12
Over-Speed Control	4B-12
Knock Retard Spark Control	4B-12
Thunderbolt V Spark Control Graph	4B-13
Circuit Description	4B-14
Ignition Control Module	4B-14
Knock Control Module	4B-14
Ignition Control System Timing Lead	4B-14
Ignition System Wiring Diagram	4B-15
Timing and Idle Adjustment Procedures For Thunderbolt V Ignition	4B-16
Setting Base Ignition Timing	4B-16
Adjusting Idle Mixture	4B-16
Adjusting Engine Idle Speed	4B-16
Troubleshooting Thunderbolt V Ignition	4B-17
Ignition Control Module /Coil /Distributor	4B-17
Knock Control Module	4B-18
Spark Plugs	4B-19
Spark Plug Wires	4B-20

Index

Thunderbolt IV (HEI) Ignition System



a - Ignition Module

72722

Special Tools

MERCURY MARINE SPECIAL TOOLS	
DESCRIPTION	**PART NUMBER**
Timing Light	91-99379
Multi Meter/DVA	91-99750
Torch Lamp	91-63209
Insulating Compound	92-41669
Quicksilver Liquid Neoprene	92-25711-2

Torque Specifications

DESCRIPTION	Lb. In.	Lb. Ft.	N·m
Distributor Clamp 3/8-16		20	27
Spark Plugs (14mm)		15	20
Ignition Module Retaining Screws (Stainless Steel)	10		1.1

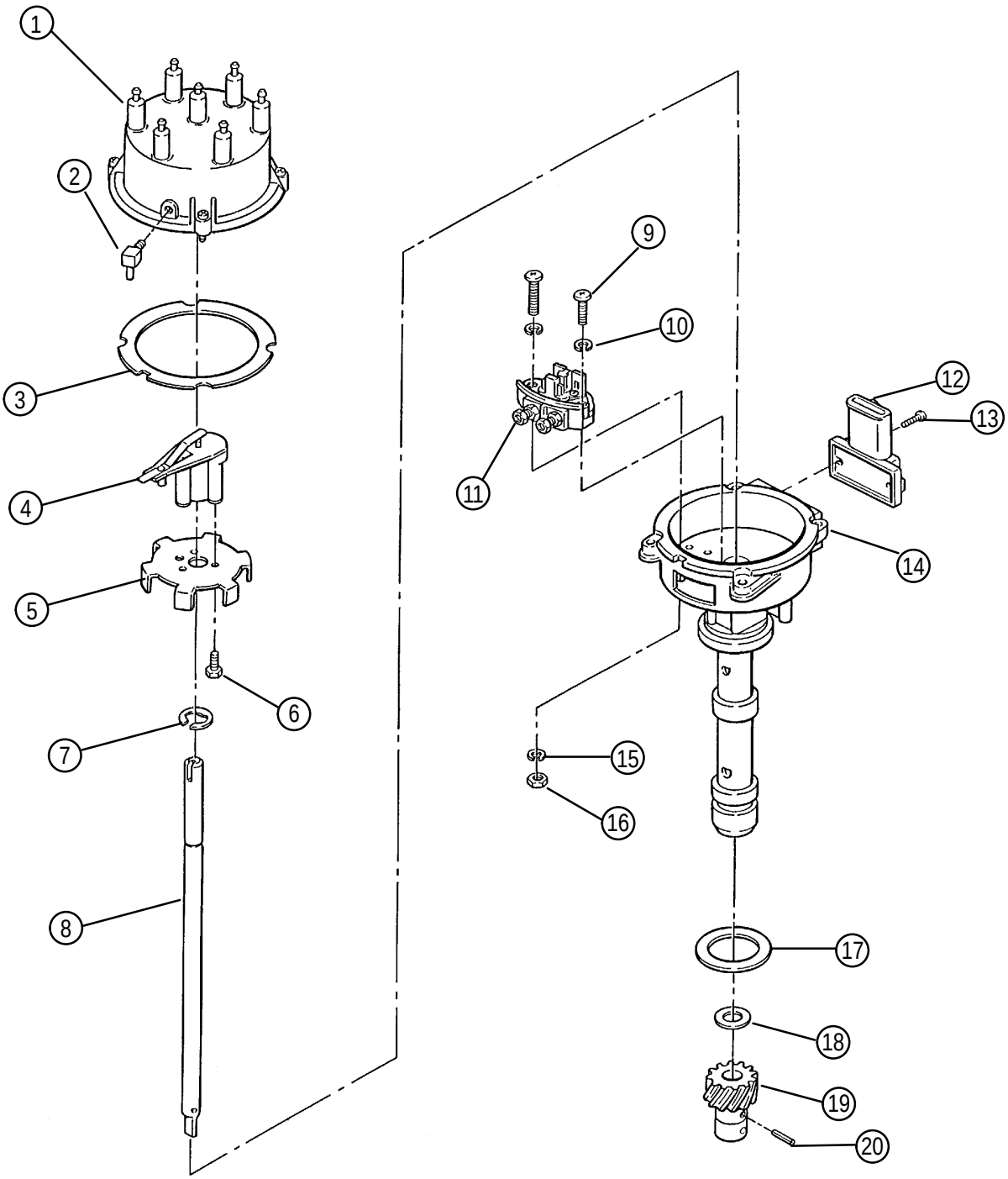
Lubricants, Sealers and Adhesives

DESCRIPTION	PART NUMBER
Loctite 271	Obtain Locally
Thermalconductive Grease	

Coil Specifications

Coil Part Number	392-7803A4
Primary Resistance	.60-.80 Ohms
Secondary Resistance	9.400-11.700 Ohms

Exploded View for Thunderbolt IV Distributor For V-6 Engines

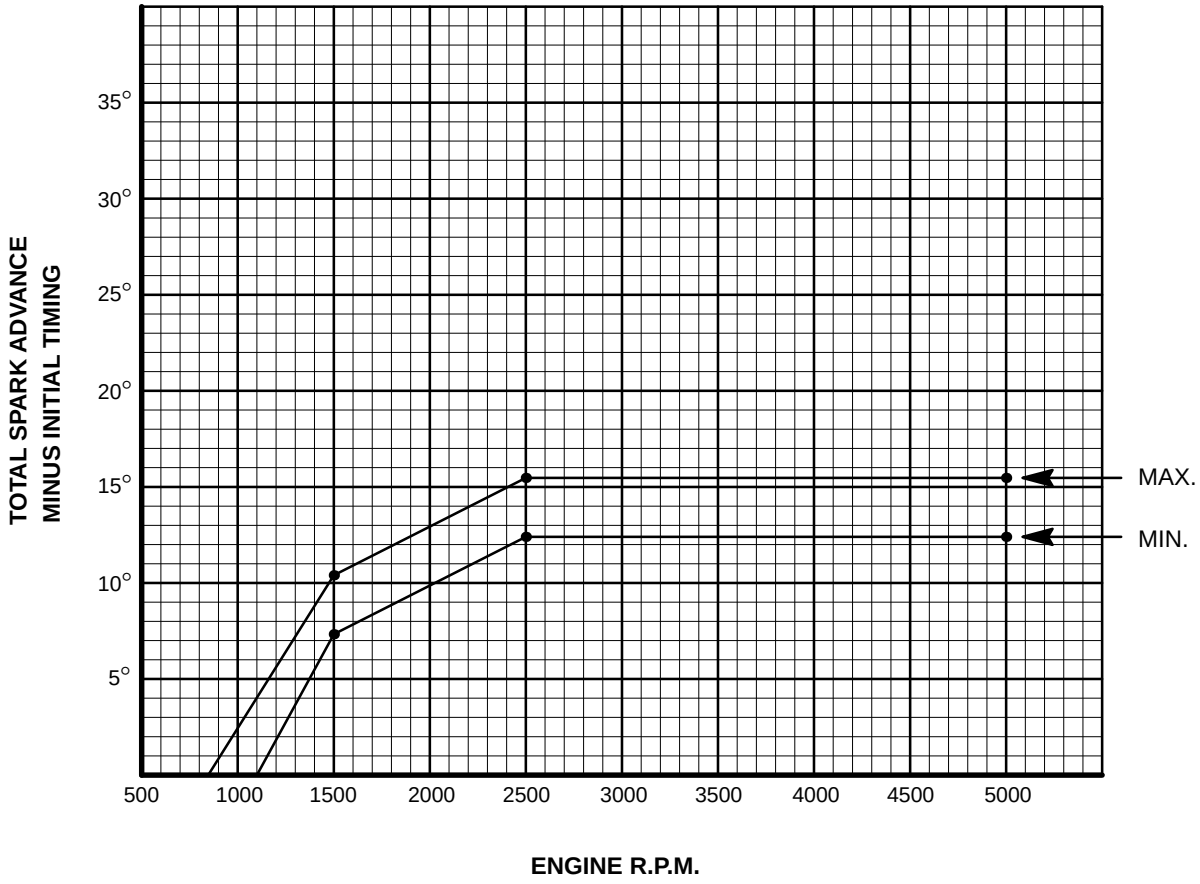


72058

1 - Distributor Cap
2 - Vent
3 - Gasket
4 - Rotor
5 - Sensor Wheel
6 - Screw (3)
7 - E-Clip
8 - Shaft
9 - Screw (2)
10- Lockwasher (2)
11- Sensor
12- Ignition Amplifier
13- Screw (2)
14- Distributor Housing
15- Lockwasher
16- Nut
17- Gasket
18- Washer
19- Gear
20- Roll Pin

MCM V-6 262 CID (4.3L) with Thunderbolt IV

Module Part Number: 805361T-1
Identification Mark: V6-14
Module Advance: 14°
Initial Timing: 8° BTDC
Total Advance: 22°



70808-7

Replacement Parts Warning

⚠WARNING

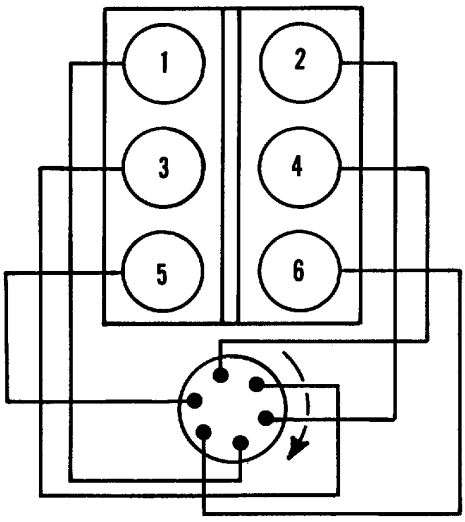
Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Spark Plugs

Model	4.3L / 4.3LX	4.3L / 4.3LX Gen +
Spark Plug Gap	.035 In. (0.9 mm)	.045 In. (1.1 mm)
Spark Plug Type	AC-MR43T NGK-BR6FS Champion RV8C	AC-MR43LTS NGK-BPR6EFS Champion RS12YC

Firing Order



Firing Order 1-6-5-4-3-2

72976

Distributor Advance Curves

1. Distributor advance curve charts do not include the initial engine timing. Basic initial timing must be added to chart for total advance curve.
2. The spark advance is controlled by the ignition module.

Repair

Precautions

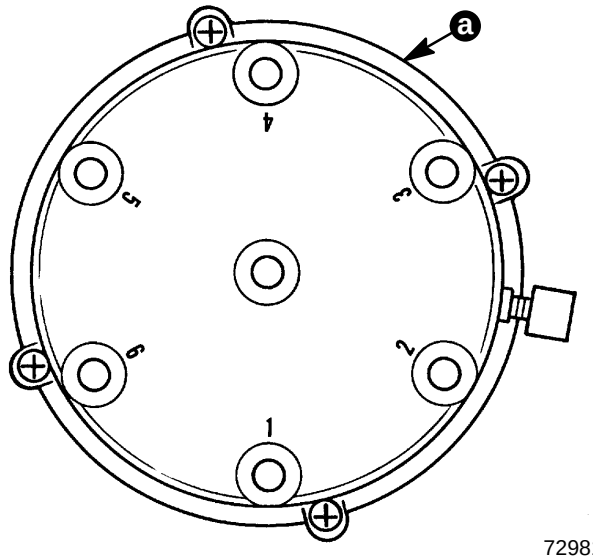
⚠WARNING

When performing the following procedure, be sure to observe the following:

- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of fire.**
- **Be sure to keep hands, feet and clothing clear of moving parts.**
- **Do not touch or disconnect any ignition system parts while engine is running.**
- **Do not reverse battery cable connections. System is negative (–) ground.**
- **Do not disconnect battery cables while engine is running.**

Distributor Cap

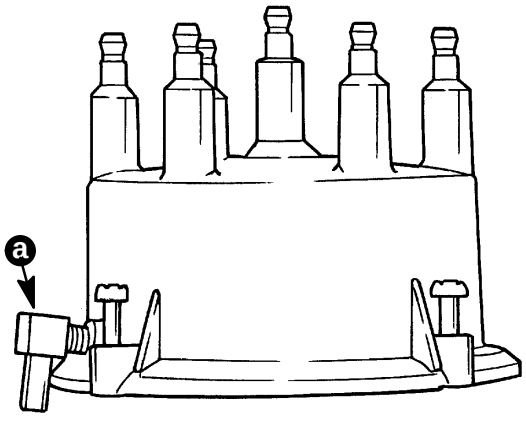
3. Loosen four distributor cap retaining screws.
4. Remove distributor cap.
5. Clean cap with warm soap and water and blow off with compressed air.
6. Check cap contact for excessive burning or corrosion. Check center contact for deterioration.
7. Check cap for cracks or carbon tracks using magneto analyzer.
8. Check condition of distributor cap gasket. Replace gasket if damaged or missing.
9. If high tension leads are removed from cap refer to "Spark Plug Wires" in this section and the following illustrations for installation.



72981

Wiring

a - Alignment Notch



72978

a - Vent

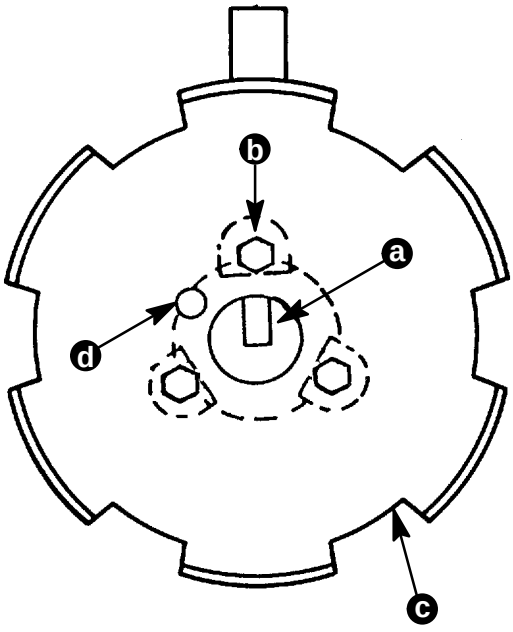
Rotor/Sensor Wheel

1. Remove distributor rotor/sensor wheel assembly from distributor shaft. Rotor and sensor wheel are secured to the shaft with Loctite. Use two flat blade screwdrivers. The screwdrivers are positioned opposite each other with the blade tips on the underside of the rotor and sensor wheel assembly. Make sure blade tips are toward distributor shaft until they come in contact with shaft. A downward push on both screwdriver handles at the same time will pry off rotor/sensor wheel assembly. The use of torch lamp will also aid in the removal of the rotor/sensor wheel assembly.

⚠WARNING

Wear protective gloves when handling heated rotor/sensor wheel assembly to avoid severe burns.

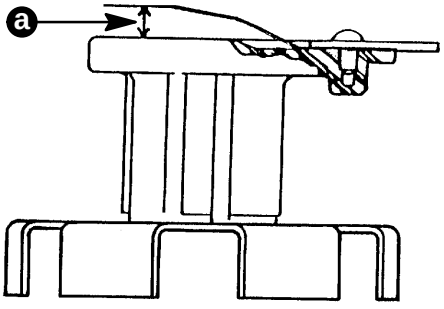
2. With the rotor/sensor wheel assembly removed, inspect the locating key inside the rotor.
3. The locating key will appear as a clean edged, 1/8 in. (3 mm) wide, sloped ramp at the bottom of the splined
hole.



72980

a - Locating Key
b - Screws (Hex Head)
c - Sensor Wheel
d - Locating Pin

4. If there is any doubt if sensor wheel is located properly, lay sensor wheel on top of the figure above with sensor fingers facing up (toward you). Line up three screw holes and locating pin hole on sensor wheel with the figure. If wheel is indexed properly all the fingers on wheel will line up with those in the figure.
5. If there are pieces of material shaved off the key or if it appears to have been damaged by being forced down while misaligned with slot in distributor shaft, the rotor must be replaced.
6. Check rotor for burned or corroded center contact.
7. Check rotor for cracks and carbon tracks using magneto analyzer and instructions supplied with analyzer.
8. If rotor is damaged, replace rotor by removing three hex bolts and separating sensor wheel from rotor. Reinstall sensor wheel to new rotor making sure locating pin on rotor is installed in locating hole in sensor wheel. Tighten three hex bolts securely.
9. Bend carbon brush tang upward slightly until a distance of 1/4 in. (6.4 mm) is obtained between rotor and tang.



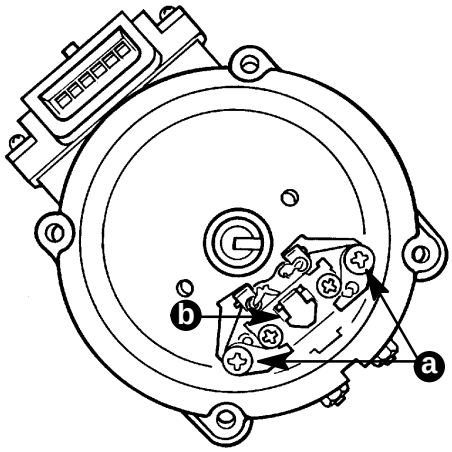
72979

a - 1/4 in. (6.5 mm)

10. Put 2 drops of Loctite 271 or Quicksilver Loctite Type A into the rotor so it lands on the locating key.
11. Put 2 drops of Loctite 271 in keyway on upper portion of distributor shaft.
12. Immediately install rotor assembly onto distributor shaft. Make sure rotor locating key is aligned with keyway in distributor shaft before pressing rotor all the way down on the shaft, until it stops, with the palm of your hand. Let Loctite cure overnight with distributor in inverted position.
13. The rotor should fit very tight. It may be necessary to heat rotor with torch lamp to properly install. It is important not to let any Loctite run down distributor shaft. Loctite could get into top distributor housing bushing.
14. Reinstall distributor cap on distributor.
15. Install spark plug wires (if removed). Refer to “Spark Plug Wires” in this section.

Sensor

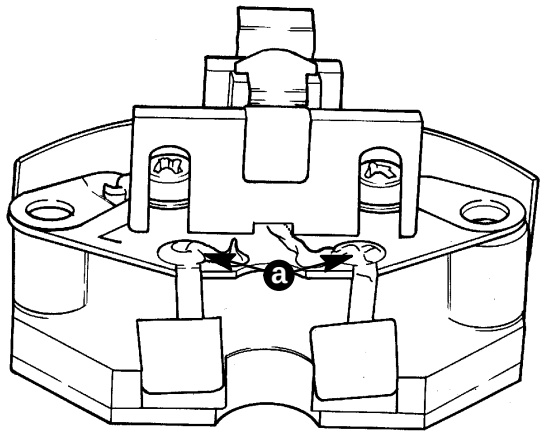
1. Remove rotor and sensor wheel.
2. Remove two screws that hold sensor into distributor housing.
3. Remove sensor from housing.



72732

a - Mounting Screws
b - Sensor Assembly

4. Use a magnifying glass and light to inspect the two metal “jumper leads” for cracks. If a crack is found in either metal “jumper lead,” install a new sensor.



72733

a - Jumper Leads

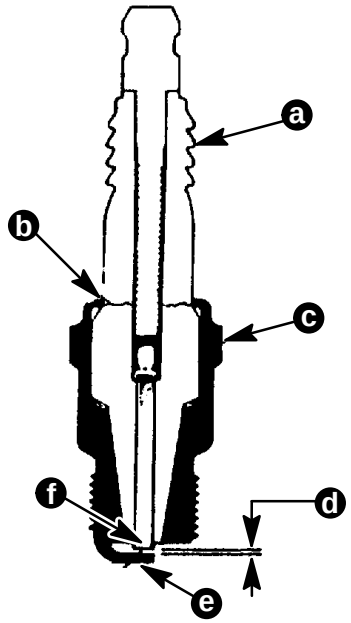
⚠CAUTION

Do not use any type of silicone sealer on the inside of the distributor. Most silicone sealers give off an acidic vapor during the curing stage of the sealer. This acid can cause corrosion on the ignition components.

5. Install sensor into housing and install two retaining screws.
6. Install sensor wheel, rotor, and distributor cap.

Spark Plugs

1. Inspect each plug individually for badly worn electrodes, glazed, broken or blistered porcelain and replace where necessary.
2. Inspect each spark plug for make and heat range. All plugs must be the same make and number and heat range. Refer to “Specifications” for spark plug numbers.
3. Adjust spark plug gaps with a round feeler gauge. Refer to “Specifications” for proper spark plug gap.



72734

a - Porcelain Insulator
b - Insulator Cracks Often Occur at This Point
c - Shell
d - Proper Gap
e - Side Electrode (Bend to Adjust Gap)
f - Center Electrode (File when Adjusting Gap - DO NOT BEND)

4. Clean spark plug seating area. Do not use gaskets on taper seat plugs. Install spark plugs and torque to specifications. Where used, gasket must be fully compressed to complete heat transfer and provide a gas- tight seal in cylinder. For this reason, as well as the necessity of maintaining correct plug gap, correct torque is very important during installation.
5. Tapered seat spark plugs are not interchangeable with non-tapered (with gasket) spark plugs.

Ignition Module

1. Unplug wiring harness connector from ignition module mounted on distributor.
2. Remove stainless steel screws retaining ignition module to distributor body. Remove module.
3. Thermalconductive Grease (92-805701) must be applied to the back of the ignition module to conduct heat away from the module and to prevent corrosion.
4. Apply a thin coat of Thermalconductive Grease evenly across the back of the ignition module.
5. Install ignition module using the stainless steel screws. Torque screws to 10 lb. in. (1.1 N·m).
6. Check that terminals of wiring harness connector are clean and free of corrosion. Plug connector into ignition module.

Spark Plug Wires

1. Inspect spark plug wires for damage.
2. Check spark plug wires for continuity.
3. Replace any wires that are cracked, cut, or have damaged spark plug boots.
4. Replace any wires that do not show continuity from end to end.
5. Reinstall spark plug wires in proper order. Observe the following.
6. Proper positioning in spark plug wire supports is important to prevent cross-firing.
7. Before installing coil wire to coil, apply approximately 1/2 oz. of insulating compound inside nipple of coil wire. Force nipple into coil and wipe off excess. Make sure boot does not “hydraulically back off” the distributor cap terminal

Distributor Repair

Removal

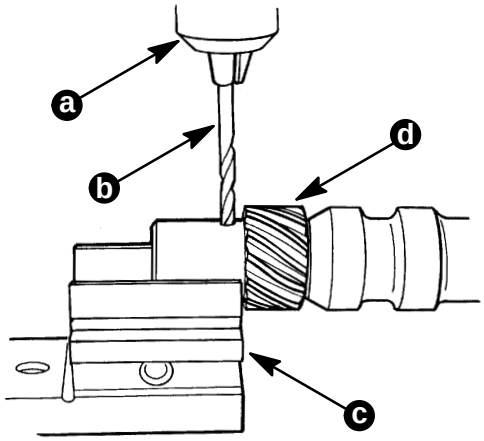
1. Unplug wiring harness from ignition amplifier on distributor housing.
2. Remove distributor cap. Do not remove high tension leads unless necessary.
3. Crank engine over until timing marks line up and rotor is pointing toward No. 1 cylinder on distributor cap.
4. Mark distributor housing in reference to engine block.
5. Remove bolt and hold-down clamp and remove distributor.
6. To simplify distributor installation, do not turn crankshaft when distributor is removed from engine.

Disassembly

1. Remove rotor, sensor wheel, and sensor as previously outlined.
2. Remove roll pin, washer and driven gear from distributor shaft.
3. Check for side play between shaft and distributor housing bushings. Maximum side play is .002 in. (0.05 mm).
4. Remove shaft from housing and check shaft for being bent with a dial indicator and V-blocks. Maximum runout is .002 in. (0.5 mm).

Reassembly

1. Lubricate shaft with engine oil. Install E-clip (if removed) on shaft in housing.
2. Install washer on shaft. Install original gear; slide onto shaft and install roll pin.
3. Hole may be offset and gear will only fit in one direction.
4. If installing a new gear, the gear will come drilled on one side. Slide gear onto shaft; align hole in gear with hole in shaft. Using these holes as guides, drill through other side of gear with a 3/16 in. carbide tripped drill.
5. If a new gear has only a dimple, you will have to drill through one side of the gear before you slide gear onto shaft. In most cases it is recommended to have a machine shop complete the drilling operation for new gear installation.



72735

a - Drill Press
b - 3/16 In. Carbide Tip Drill
c - V - Block
d - New Gear

6. Install sensor, sensor wheel, and rotor as previously outlined.
7. Install distributor as outlined in “Distributor Installation.”

Distributor Installation

Engine Not Disturbed

1. Install new gasket on distributor housing.
2. Turn rotor approximately 1/8-turn in a counterclockwise direction past mark previously scratched on distributor housing.
3. Work distributor down into position in engine block with distributor positioned as noted during removal.
4. It may be necessary to move rotor slightly to start gear into mesh with camshaft gear, but rotor should line up with the mark when distributor is down in place. Distributor shaft must enter oil pump shaft for complete installation.
5. Replace and tighten distributor hold-down bolt and clamp. Connect leads. Also install spark plug and coil secondary wires, if removed.
6. Install cap. Refer to “Spark Plug Wires ” and install wires.
7. Plug wiring harness into ignition amplifier on distributor housing.
8. Time ignition as outlined under “Ignition Timing.”

Engine Disturbed

⚠CAUTION

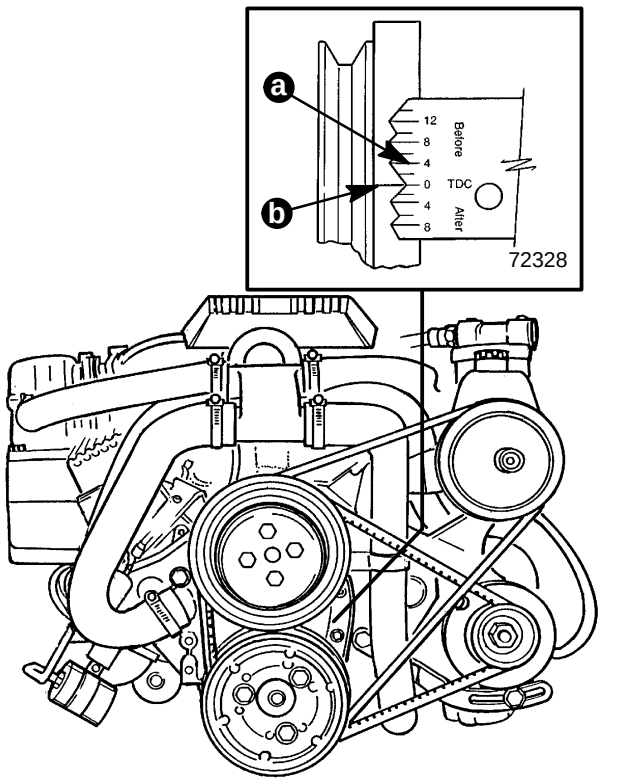
If timing chain has been aligned as outlined in Section 3A - "Timing Chain and Sprocket," the No. 4 cylinder is on compression (TDC) and the distributor MUST BE installed with the rotor positioned at the No. 4 post on the distributor cap.

Electrical timing on No. 1 spark plug remains the same as outlined following.

1. Locate No. 1 piston in firing position by either of two methods described below.
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until pointer lines up with timing mark on crankshaft pulley, or
   b. Remove rocker cover and crank engine until No. 1 intake valve closes, continuing to crank slowly until pointer lines up with timing mark on crankshaft pulley.
2. Position distributor to opening in block in normal installed attitude.
3. Position rotor to point toward No. 1 cylinder on cap (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately 1/8-turn more and push distributor down to engage camshaft. It may be necessary to rotate rotor slightly until camshaft engagement is felt.
4. While pressing down firmly on distributor housing, engage starter a few times to make sure oil pump shaft is engaged. Install hold-down clamp and bolt and snug up bolt.
5. Place distributor cap in position and check that rotor lines up with terminal for No. 1 spark plug. Install cap.
6. Refer to "High Tension Leads" and install wires. Refer to "Specifications" for firing order.
7. Time ignition as outlined under "Ignition Timing."

Ignition Timing

1. Connect timing light to No. 1 spark plug. Connect power supply leads on light to 12 volt battery. Refer to "Specifications" for cylinder numbering and location.
2. Connect tachometer to engine.
3. Start engine and run at normal idle speed.
4. Aim timing light at timing tab, located on timing gear cover and crankshaft torsional damper.
5. GM engine timing marks (on tab) are in 2-degree increments. MCM LH engines will have "A" (Advance) mark to the left of "0." Timing must be set on the "A" side of "0" (Top Dead Center).



72872

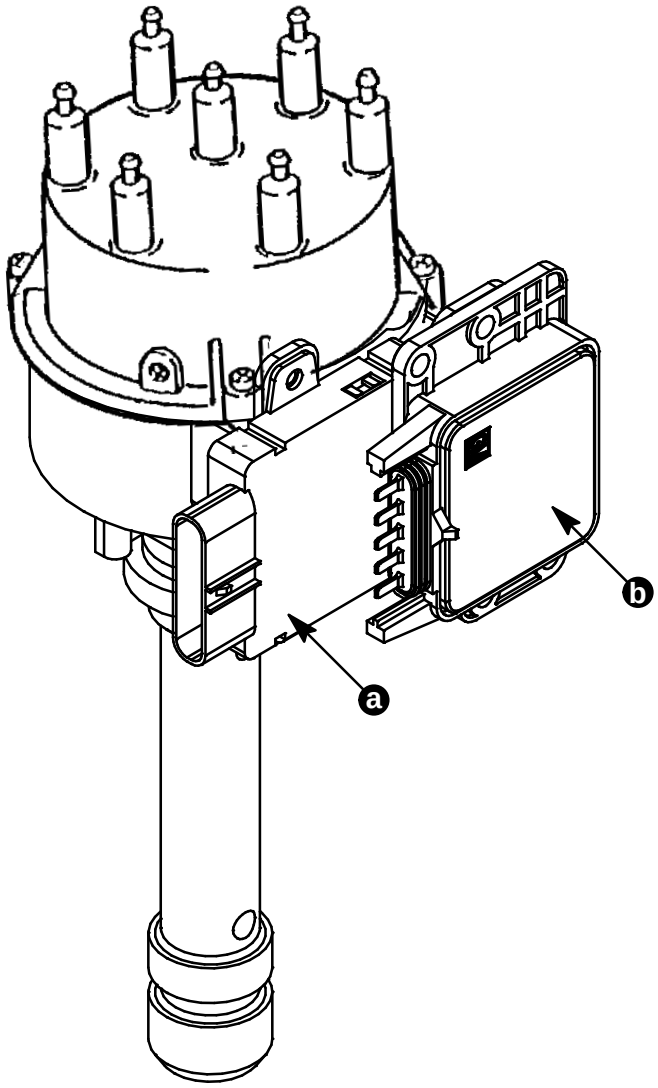
a - Degree Marks
b - Timing Mark

6. Adjust timing by loosening distributor clamp and rotating distributor body as required until timing mark on damper or pulley lines up with the mark on tab specified in "Specifications." Tighten clamp and recheck location of timing mark.
7. Stop engine and remove timing light.

Thunderbolt V Ignition System

Identification

The Thunderbolt V ignition system uses the same distributor as the Thunderbolt IV system. The Ignition Control Module and Knock Control Module are mounted with the ignition control module.



73999

a - Ignition Control Module
b - Knock Control Module

General Description

The Thunderbolt V ignition system has several spark control features that will be described following:

- Idle Speed Spark Control
- Acceleration Spark Advance
- Mean-Best-Timing Spark Advance
- Over-Speed Control (Rev-Limiter)
- Knock Retard Spark Control

Idle Speed Spark Control

The ignition module will control ignition timing to maintain a calibrated idle speed. This is accomplished by making small spark advance adjustments. This feature is only active within a certain RPM range. This range may be slightly different from one engine model to another. The approximate range is 400-700 RPM.

Acceleration Spark Advance

This feature is active during acceleration only. When accelerating, the ignition module may add more spark advance to the “Base Spark Timing Curve”. The amount of spark advance added, is totally dependant on how fast RPM increases (how fast the throttle is moved). This feature is also active within a certain RPM range. This range may be slightly different from one engine model to another. The approximate RPM range for this feature is 1200-4000 RPM. Within this range, the module can add approximately 10 degrees of spark advance to the base spark timing curve.

Mean-Best-Timing (MBT) Spark Advance

During light load cruising, the ignition module searches for the optimal ignition timing. This is also accomplished by small changes to the spark advance. At a given RPM, the module will try to add a small amount of advance and wait to see if there is an RPM change. If RPM increases, it will try to increase timing more. The module will continue to advance timing until it no longer gets an increase in RPM. Conversely, if it senses an RPM drop, it will start to retard some of the spark timing. The approximate RPM range for this feature is 1200-4000 RPM. Within this range, the ignition module can add approximately 10-15 degrees of spark advance to the base spark timing curve.

NOTE: *The Audio Warning System is also connected into the ignition module circuit. If the audio warning system becomes activated by the closing of one of the audio warning system switches, the MBT feature is deactivated.*

Over-Speed Control

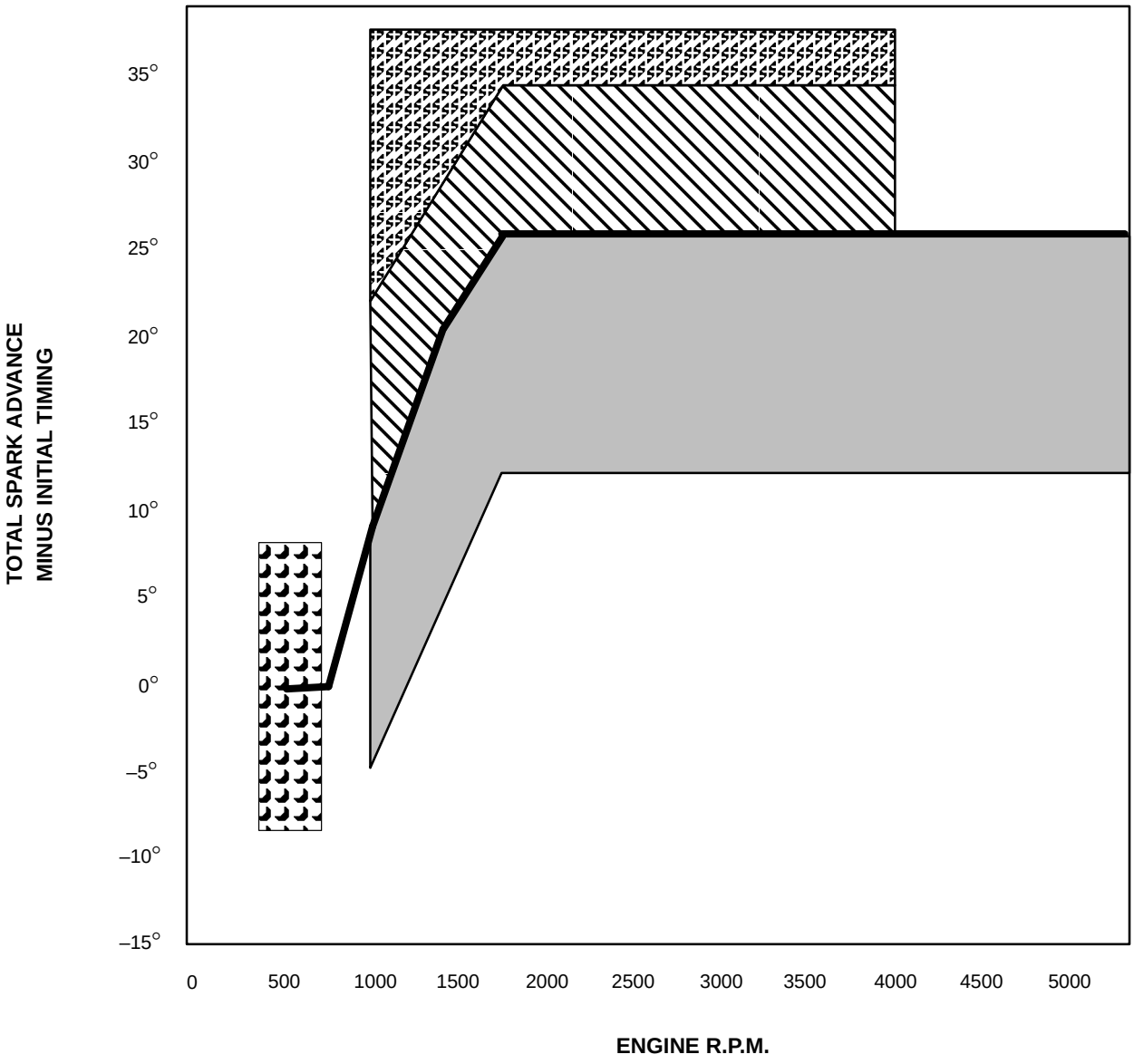
The ignition module will prevent the engine speed from exceeding a preset limit by stopping the spark. This feature has an RPM range that varies from model to model. The over-speed limit for a particular engine is set slightly higher than the top end of the RPM range for that model. For example, if the recommended range is 4600-5000 RPM, the over-speed limit would be set at 5100 RPM. When RPM reaches this limit, spark is turned-off until engine RPM drops down to a “Reset RPM”, which would be approximately 4750 RPM for this example. At this point, spark comes back on.

Knock Retard Spark Control

The knock control feature helps provide protection from harmful detonation. Knock control is handled by the Knock Control Module. This module receives a signal from a sensor that is mounted on the engine block. The knock control module works in conjunction with the ignition module to retard the timing if spark knock is present.

Thunderbolt V Spark Control Graph

IMPORTANT: The graph below shows the typical advance ranges for a Thunderbolt V ignition control module. The numbers plotted on the graph are not representative of any particular model. It is only presented to provide an understanding of how the system functions.



= Base Timing Advance Curve

= Idle Speed Advance Range

= Knock Retard Range

= Acceleration Advance Range

= MBT Advance Range

Circuit Description

Refer to the circuit wiring diagram on the following page for reference to this circuit description.

Ignition Control Module

- The ignition module receives its power (+) thru the PURPLE wire “9”.
- Ignition module ground (–) is accomplished thru the BLACK wire “10”.
- There is also a Case Ground (–) wire “12” that is connected to one of the ignition module attaching screws.
- The 12 volt signal from the ignition module to the distributor is carried thru the WHITE/RED wire “8”, to the distributor sensor and back to the ignition module thru the WHITE/GREEN wire “7”.
- The tachometer signal is carried to the instrument panel thru the GRAY wire “11”.
- The PURPLE/WHITE wire “3” carries the signal from the knock control module to the ignition control module.
- There are two BLACK wires “5” that have bullet connectors. This circuit is reserved for future options. On current models, the two BLACK wires must be connected for the system to function properly.
- The TAN/BLU wire “6” carries a signal from the Audio Warning circuit to the ignition module.

Knock Control Module

- The knock control module receives it’s power (+) from the PURPLE wire “4”.
- Knock module ground (–) is accomplished thru the BLACK wire “2”.
- The PURPLE/WHITE wire “3” carries the signal from the knock control module to the ignition control module.
- The BLUE wire “1” carries the signal from the knock sensor to the knock module.

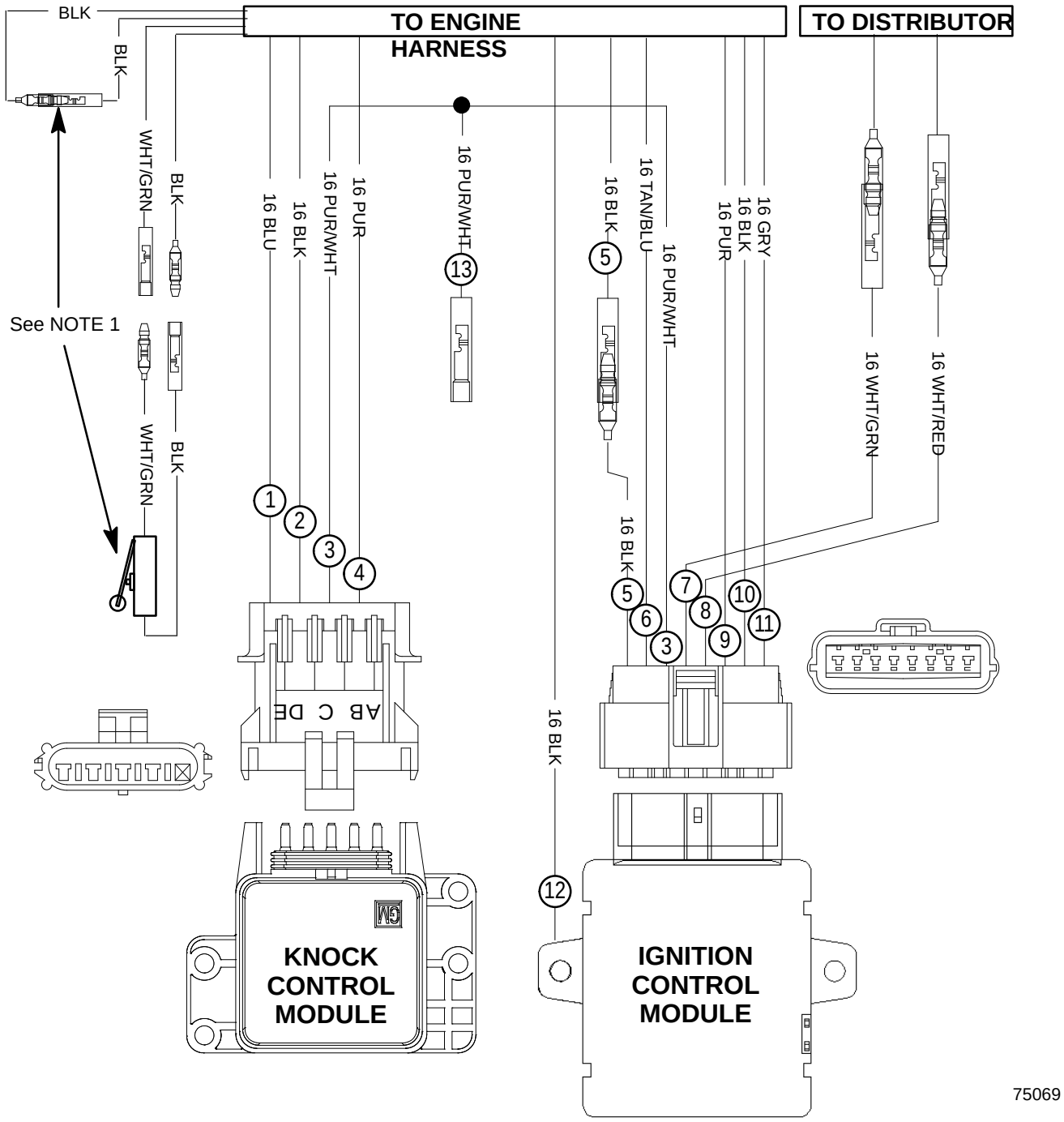
Ignition Control System Timing Lead

The ignition control system has a lead with bullet connector “11” that is connected into the PURPLE/WHITE wire “3”. This lead is used for performing the following tests and procedures:

- Setting “Base Ignition Timing”
- Setting “Engine Idle Speed”
- Setting “Idle Mixture”
- Testing Knock Control Circuit

This lead, when connected to an engine ground (–), locks the ignition control module into the “Base Timing” mode.

Ignition System Wiring Diagram



NOTE 1: Alpha Models Are Equipped With A Shift Cut-Out Switch. Bravo Models Will Have Two BLACK Leads Connected Together.

NOTE 2: Some Wiring Harnesses Will Not Have The Bullet Connector In This Location. Bravo Only Wiring Harness Will Have A BLACK Wire. Harness Used For Bravo And Alpha Will Have A WHITE/GREEN Wire.

1 - Knock Sensor Wire
2 - Ground Wire (–) For Knock Module
3 - Knock Module Signal Wire
4 - Battery (+) Positive Wire To Knock Module
5 - Ground (–) For Future Options
6 - Audio Warning System Wire
7 - Distributor Wire
8 - Distributor Wire
9 - Battery (+) Positive Wire To Ignition Module
10- Ground Wire For Ignition Module
11- Tachometer Wire
12- Ignition Module Case Ground (–)
13- Timing Lead (For Setting Timing and Other Tests)

Timing and Idle Adjustment Procedures For Thunderbolt V Ignition

Setting Base Ignition Timing

1. Connect timing light to number 1 spark plug. Connect timing light power supply leads (if applicable) to 12 volt source.
2. Connect a shop tachometer to engine.
3. Using a jumper wire, connect the ignition system timing lead “13” (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the “Base Timing Mode”.
4. Start engine and run at normal idle speed. Allow engine to reach normal operating temperature.
5. Aim timing light at timing tab, located on the timing gear cover and crankshaft torsional damper.
6. Adjust timing using the conventional method.

IMPORTANT: Be sure to disconnect the jumper wire from the ignition system test terminal before attempting to resume normal operations. If the jumper wire is left in place, the ignition module will operate in the “Base Timing Mode”. This means that the additional timing advance features would not function.

7. Make sure that the distributor has been tightened. Remove the jumper wire from the timing terminal.
8. Stop engine and remove timing light.

Adjusting Idle Mixture

The procedure for adjusting carburetor idle mixture can be found in the appropriate engine service manual. This procedure also requires that the ignition module be locked in the “Base Timing Mode”.

IMPORTANT: In order to properly set idle mixture, the ignition module MUST BE locked in the “Base Timing Mode”. This is necessary because of the “Idle Speed Control” feature that exists in the ignition module. See information on the previous pages about this feature.

1. Using a jumper wire, connect the ignition system timing lead “13” (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the “Base Timing Mode”.
2. Adjust idle mixture following the procedure in the appropriate engine service manual.
3. Remove the jumper wire from the timing terminal.

Adjusting Engine Idle Speed

This procedure should be done with boat in the water, drive unit in neutral and engine at normal operating temperature. Refer to the Operation and Maintenance Manual for the correct idle speed.

1. Disconnect the throttle cable from carburetor.

IMPORTANT: In order to properly set idle speed, the ignition module MUST BE locked in the “Base Timing Mode”. This is necessary because of the “Idle Speed Control” feature that exists in the ignition module. See information on the previous pages about this feature.

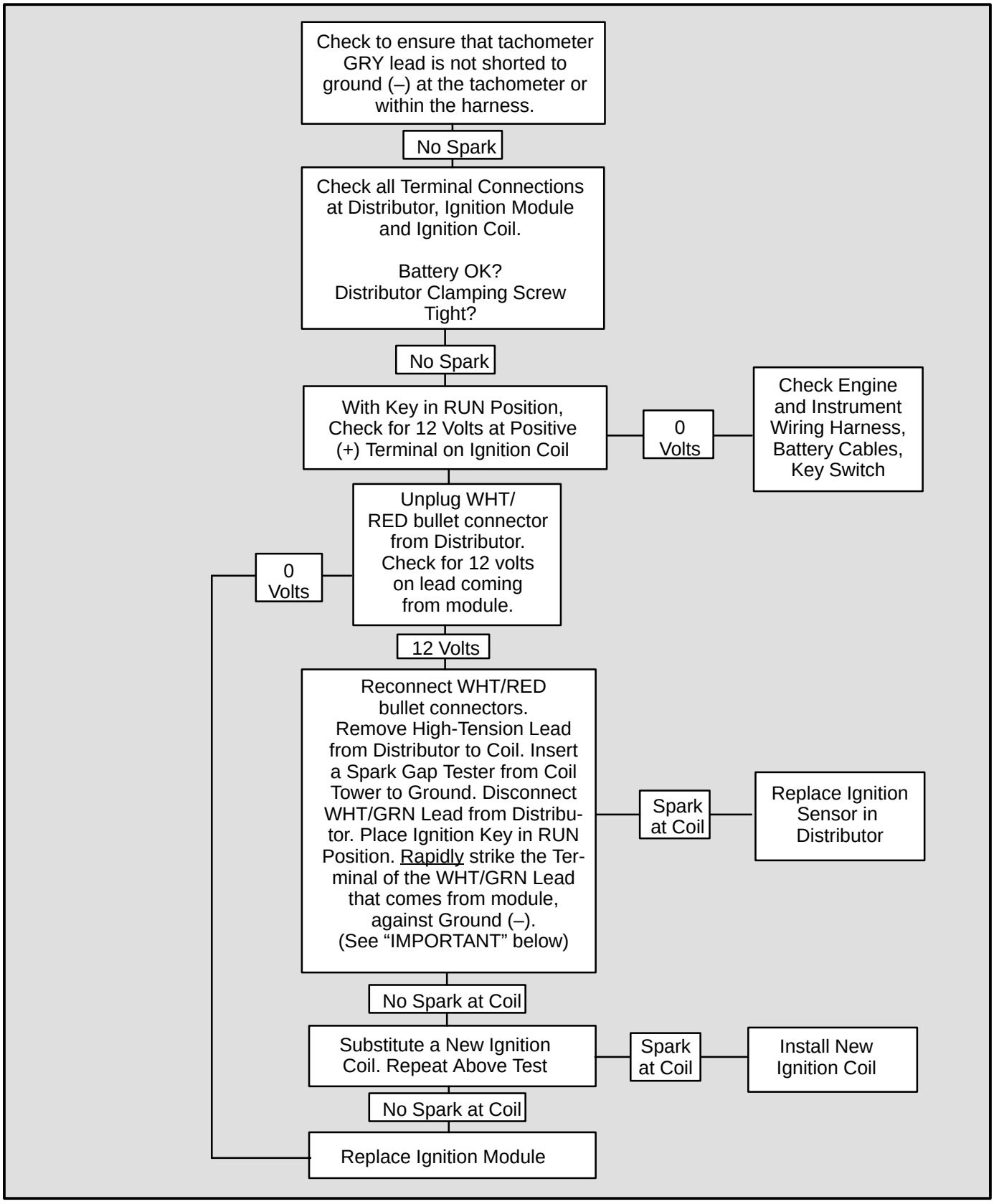
2. Connect a shop tachometer to engine.
3. Using a jumper wire, connect the ignition system timing lead “13” (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the “Base Timing Mode”.
4. Start engine and allow it to reach normal operating temperature.
5. Adjust idle speed to recommended RPM.
6. Stop engine. Readjust cable barrel and reinstall the throttle.

IMPORTANT: Be sure to disconnect the jumper wire from the ignition system test terminal before attempting to resume normal operations. If the jumper wire is left in place, the ignition module will operate in the “Base Timing Mode”. This means that the additional timing advance features would not be functioning.

7. Remove the jumper wire from the timing terminal.

Troubleshooting Thunderbolt V Ignition

Ignition Control Module /Coil /Distributor

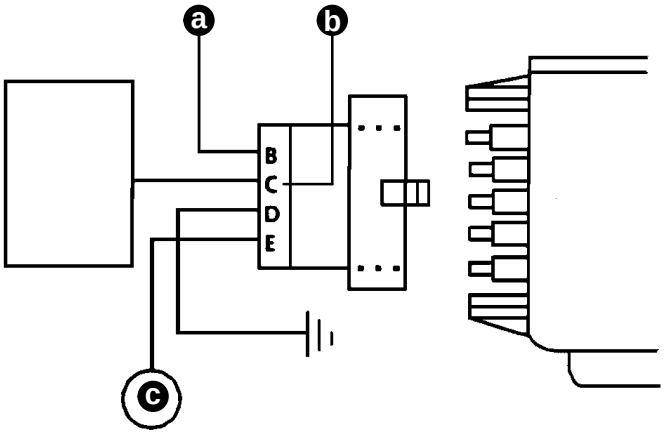

Check to ensure that tachometer GRY lead is not shorted to ground (–) at the tachometer or within the harness.
No Spark
Check all Terminal Connections at Distributor, Ignition Module and Ignition Coil.
Battery OK?
Distributor Clamping Screw Tight?
No Spark
With Key in RUN Position, Check for 12 Volts at Positive (+) Terminal on Ignition Coil
0 Volts
Check Engine and Instrument Wiring Harness, Battery Cables, Key Switch
Unplug WHT/ RED bullet connector from Distributor. Check for 12 volts on lead coming from module.
0 Volts
12 Volts
Reconnect WHT/RED bullet connectors. Remove High-Tension Lead from Distributor to Coil. Insert a Spark Gap Tester from Coil Tower to Ground. Disconnect WHT/GRN Lead from Distributor. Place Ignition Key in RUN Position. Rapidly strike the Terminal of the WHT/GRN Lead that comes from module, against Ground (–). (See “IMPORTANT” below)
Spark at Coil
Replace Ignition Sensor in Distributor
No Spark at Coil
Substitute a New Ignition Coil. Repeat Above Test
Spark at Coil
Install New Ignition Coil
No Spark at Coil
Replace Ignition Module

IMPORTANT: The WHT/GRN lead must be touched against ground (–) 2-3 times per second to simulate a running engine. Repeat this test several times to ensure that spark is present.

Index

Knock Control Module

The Knock Control Module contains solid state circuitry which monitors the knock sensor's AC voltage signal and then supplies an 8-10 volt signal, if no spark knock is present, to the Ignition Control Module. If spark knock is present, the Knock module will remove the 8-10 volt signal to the Ignition Control Module.



Knock Sensor System

a - Positive Lead (12 Volts)
b - 8-10 Volts To Knock Sensor
c - Knock Sensor

It is extremely important that the correct knock module and sensor be used for the engine application. Using an incorrect knock module or sensor will result in unrecognized spark knock and engine damage. The Knock module terminal B is powered by 12 volts from the ignition switch. If the 12 volt power source is not present, the knock module cannot send an 8-10 volt signal to the ignition control module and a false constant spark retard will result.

Terminal "E" of the knock module is the signal line from the knock sensor. If this circuit opens or shorts to ground, the knock module will never remove the 8-10 volt signal from terminal "C" to and no spark retard will occur. The ground circuit for the knock module is connected to terminal "D". If the ground circuit opens, the knock module will not be able to remove the 8-10 volt signal and spark knock cannot be controlled.

IMPORTANT: If knock sensor wire is routed too close to secondary ignition wires, the Knock module may see the interference as a knock signal, resulting in false timing retard.

IMPORTANT: If there is abnormal mechanical engine noise (rattles or knocks), they may give a false knock retard signal. If fuel octane is too high or too low, a false signal can also be sent.

TESTING KNOCK MODULE AND SENSOR

NOTE: *A digital volt–ohmmeter (DVOM) and an unpowered test light (low power test light - 300mA or less) are needed to conduct the following test.*

⚠WARNING

Avoid fire or explosion. Ensure that engine compartment is well ventilated and gasoline vapors are not present when performing electrical tests inside the engine compartment. Sparks generated by electrical tests could ignite gasoline vapors causing fire or explosion.

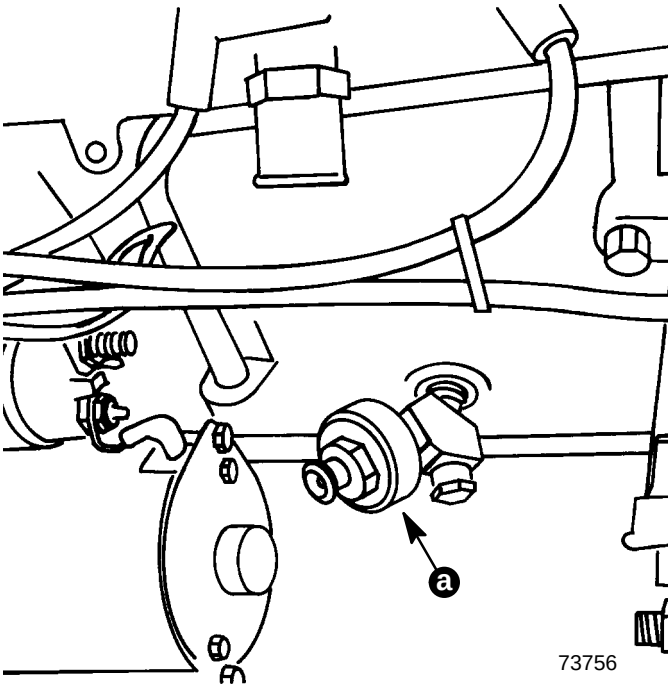
1. Start engine and warm it up to normal operating temperature.
2. Connect the positive (+) lead from the DVOM to the PURPLE/WHITE timing terminal that comes from the engine harness (see previous wiring diagram). Connect the negative (–) lead from the DVOM to a good engine ground (–). With the engine running, there should be 8-10 volts on this circuit. If voltage is not present, check to ensure that there is 12 volts to the knock module (PURPLE wire Terminal "B").
3. Advance the throttle to approximately 1500 RPM.
4. Disconnect the harness connector (BLUE wire) from the knock sensor. Connect the unpowered test light to a positive (+) 12 volt source. To simulate an AC voltage, rapidly tap the knock sensor harness terminal with the test light. If knock module and wiring is functioning properly, you should see a voltage drop on the DVOM. If a voltage drop is not seen, check the BLUE wire from the sensor to the knock module for a short or open circuit. If the circuit is functioning properly to this point, the knock sensor may not be functioning. Proceed to the following step.
5. Reconnect the knock sensor harness connector to the sensor.
6. While still watching the DVOM, lightly and rapidly tap on the engine block near the knock sensor with a small hammer. If the knock sensor is functioning properly, you should see the voltage decrease. If a voltage drop is not seen, the knock sensor is faulty.

INSTALLATION OF KNOCK SENSOR

IMPORTANT: If installing a new knock sensor, be sure to replace it with an identical part. Knock sensors are very sensitive and designed for each specific application.

IMPORTANT: It is very important that the knock sensor be torqued to the exact specification. Incorrect torque procedure will result in unsatisfactory performance. DO NOT use sealer on threads.

1. Install knock sensor in engine block. Torque to 12-16 lb. ft. (16.3-21.7 N·m).

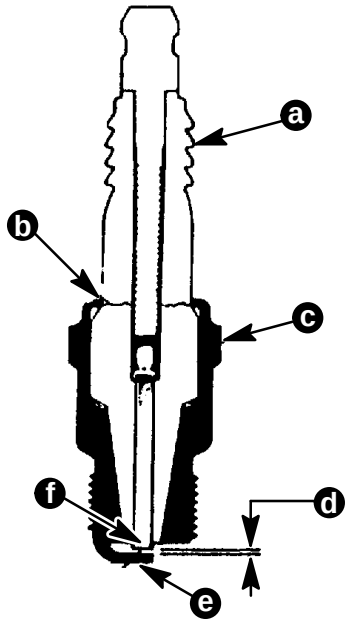


a - Knock Sensor

2. Connect electrical connector to knock sensor.

Spark Plugs

1. Inspect each plug individually for badly worn electrodes, glazed, broken or blistered porcelain and replace where necessary.
2. Inspect each spark plug for make and heat range. All plugs must be the same make and number and heat range. Refer to “Specifications” for spark plug numbers.
3. Adjust spark plug gaps with a round feeler gauge. Refer to “Specifications” for proper spark plug gap.



a - Porcelain Insulator
b - Insulator Cracks Often At This Point
c - Shell
d - Proper Gap
e - Side Electrode (Bend To Adjust Gap)
f - Center Electrode (File When Adjusting Gap - DO NOT Bend)

4. Clean spark plug seating area. Do not use gaskets on taper seat plugs. Install spark plugs and torque to specifications. Where used, gasket must be fully compressed to complete heat transfer and provide a gas- tight seal in cylinder. For this reason, as well as the necessity of maintaining correct plug gap, correct torque is very important during installation.

IMPORTANT: Tapered seat spark plugs are not interchangeable with non-tapered (with gasket) spark plugs.

Spark Plug Wires

1. Inspect spark plugs for damage.
2. Check spark plugs for continuity using Multi-Meter / DVA (91-99750) or similar.
3. Replace any wires that are cracked, cut, or have damaged spark plug boots.
4. Replace any wires that do not show continuity from end to end.
5. Reinstall wires in proper order. Observe the following:

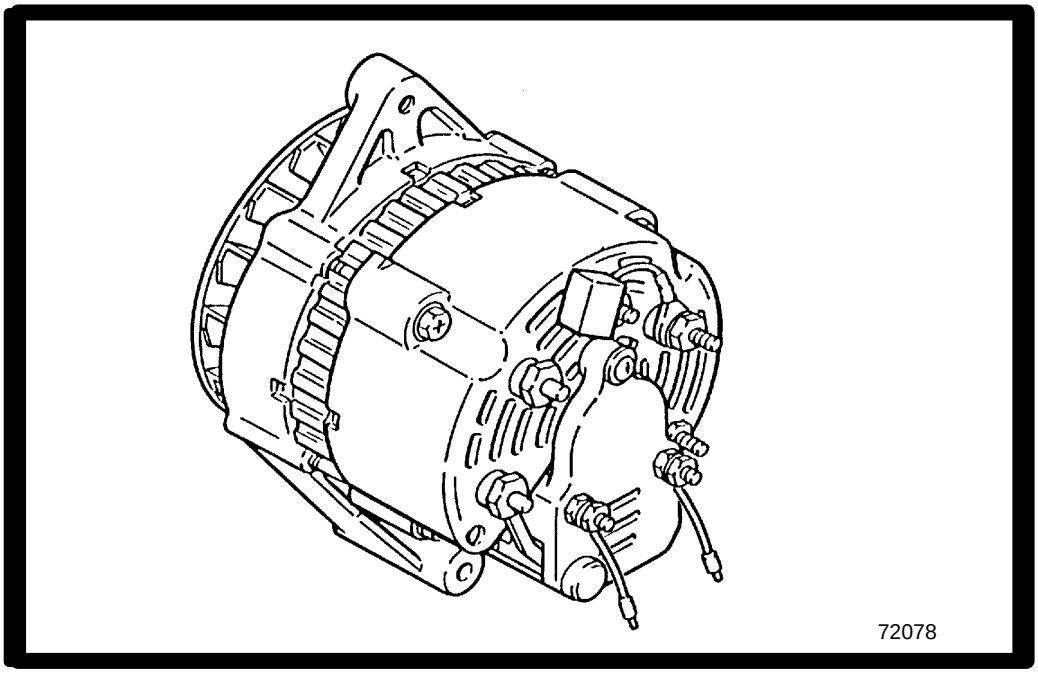
IMPORTANT: Proper positioning in spark plug wire supports is important to prevent cross-firing.

IMPORTANT: Before installing coil wire to coil, apply approximately 1/2 oz. of insulating compound around top of coil lead tower. Force nipple into coil and wipe off excess. Make sure boot does not "hydraulically back off" the distributor cap terminal.

ELECTRICAL SYSTEM

4

C



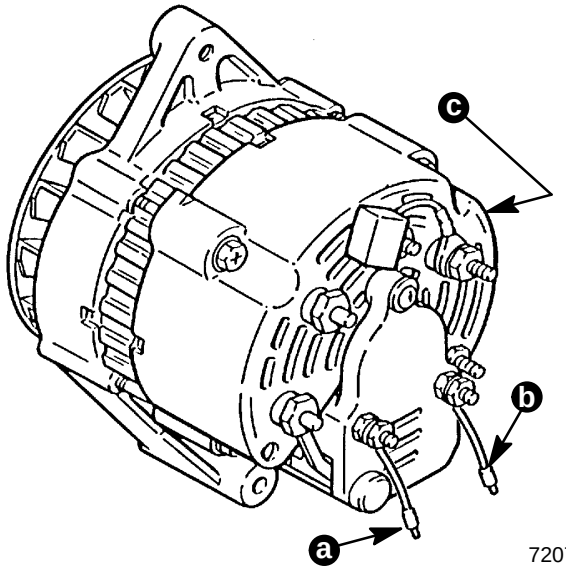
CHARGING SYSTEM

Index

Table of Contents

	Page
Identification	4C-1
Replacement Parts Warning	4C-1
Mando 55 and 65 Amp Alternator	4C-1
Specifications	4C-1
Tools/Sealants	4C-1
Torque Specifications	4C-2
Description	4C-2
Precautions	4C-2
System Components	4C-3
Periodic Maintenance	4C-3
Drive Belt Tension Adjustment	4C-4
V-Belt	4C-4
Serpentine Belt	4C-4
Troubleshooting Tests (Alternator on Engine)	4C-5
Circuitry Test	4C-5
Current Output Test	4C-6
Voltage Output Test	4C-7
Alternator Repair	4C-8
Removal	4C-8
Exploded View	4C-9
Disassembly	4C-10
Cleaning and Inspection	4C-12
Component Testing	4C-13
Reassembly	4C-16
Installation	4C-19
Battery Isolators	4C-19
Dual Battery Charging Systems Using a Battery Isolator	4C-19
Battery Isolator	4C-20

Identification



Mando 55 and 65 Amp Alternator

a - Excitation Wire - PURPLE
b - Sensing Wire - RED/PURPLE
c - Mando Part Number (Hidden In This View)

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Mando 55 and 65 Amp Alternator

Specifications

Description	Specification
Excitation Circuit	1.3 to 2.5 Volts
Current Output 55 Amp.	50 Amp. Min.
65 Amp.	60 Amp. Min.
Voltage Output	13.9 to 14.7 Volts
Min. Brush Length	1/4 in. (6 mm)

Tools/Sealants

Description	Part Number
Bearing Removal and Installation Kit	91-31229A5
Magneto Analyzer	91-76032
Universal Puller Plate	91-37241
Multi-Meter/DVA Tester	91-99750
Quicksilver Liquid Neoprene	92-27511-2
Ammeter (0-50 mm)	Obtain Locally

Torque Specifications

Fastener Location	In. Lb.	Ft. Lb.	N·m
End Frame Screws	55		5.5
Brush Setscrews	18		1.5
Regulator Mounting Screws	42		4.2
Regulator Leads	25		2.5
Ground Terminal Nut	25		2.5
Pulley Nut	42		4.2
Alternator Brace to Alternator		20	27
Alternator Brace to Block		30	41
Alternator to Mounting Bracket		35	48
Alternator Mounting Bracket		30	41
V-Belt Tension	Depress 1/4 in		
Serpentine Belt Tension			

Description

The alternator has a rotor, which is supported in two end frames by ball bearings, and is driven by a pulley at approximately twice engine speed. The rotor contains a field winding that is enclosed between two multiple-finger pole pieces. The ends of the field winding are connected to two brushes (mounted in the rear end frame) which make continuous sliding (or slipping) contact with the slip rings. The current (flowing through the field winding) creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

A 3-phase stator is mounted directly over the rotor pole pieces and between two end frames. It consists of three windings wound 120 degrees electrically out-of-phase on the inside of a laminated core. The windings are all connected together on one end, while the other ends are connected to a full-wave rectifier bridge.

The rectifier bridge contains six diodes which are arranged so that current flows from ground, through the stator and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding, and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge then changes this alternating current to direct current which appears at the output terminal. A diode trio also is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by regulating the current supplied to the rotor field. This is accomplished by a transistorized voltage regulator that senses the voltage at the battery and regulates the field current to maintain alternator voltage within prescribed limits for properly charging the battery. Current output of the alternator does not require regulation, as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cut-out relay in the voltage regulator also is not required, as the rectifier diodes (which allow current to flow in one direction only) prevent the battery from discharging back through the stator.

Due to the lack of residual magnetism in the rotor pole pieces, a small amount of current must be supplied to the rotor field to initially start the alternator charging. This is accomplished by means of an excitation circuit in the regulator which is connected to the ignition switch. Once the alternator begins to produce output, field current is supplied solely by the diode trio, as explained, preceding.

The alternator also is equipped with a fan (mounted on the rotor shaft) which induces air flow through the alternator to remove the heat created by the rectifiers and stator. A capacitor protects the rectifier system from high voltages and suppresses radio noise.

Precautions

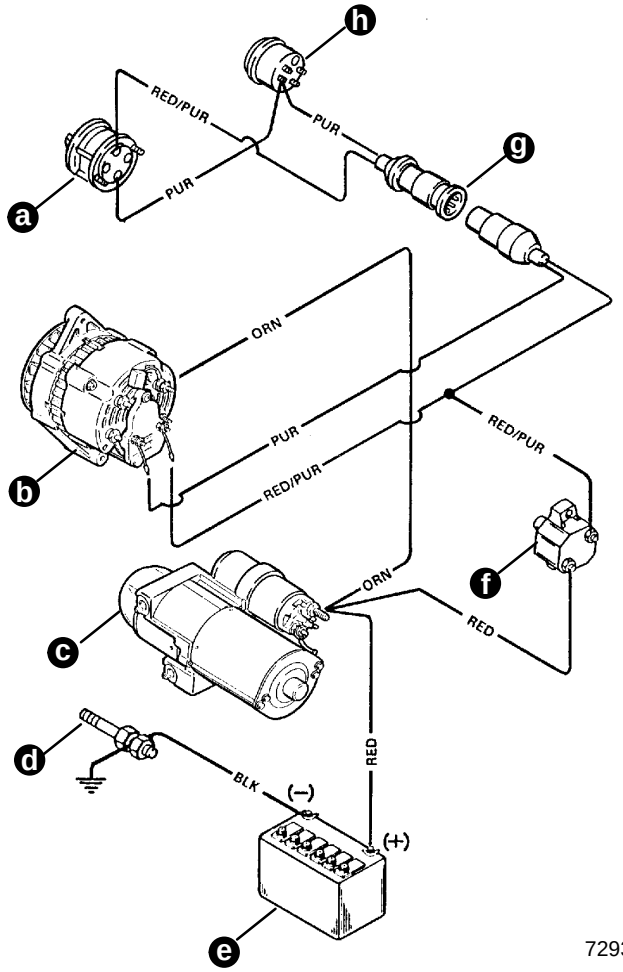
The following precautions MUST BE observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator or alternator system.

1. DO NOT attempt to polarize the alternator.
2. DO NOT short across or ground any of the terminals on the alternator, except as specifically instructed in the “Troubleshooting Tests.”
3. NEVER disconnect the alternator output lead or battery cables when the alternator is being driven by the engine.

4. NEVER disconnect regulator lead from alternator regulator terminal when the alternator is being driven by the engine.
5. ALWAYS remove negative (–) battery cable from battery before working on alternator system.
6. When installing battery, BE SURE to connect the positive (+) battery cable to the positive (+) battery terminal and the negative (–) (grounded) battery cable to negative (–) battery terminal.
7. If a charger or booster battery is to be used, BE SURE to connect it in parallel with existing battery (positive to positive; negative to negative).

System Components

The alternator system consists of the alternator, battery, the ignition switch and the wiring which connects these components.



72933

a - Ignition Switch
b - Alternator
c - Starter Motor
d - Ground Stud
e - Battery
f - Circuit Breaker
g - Harness Plug
h - Battery Meter

Periodic Maintenance

The following maintenance check should be performed every 50 hours or 60 days (whichever comes first) in fresh water areas or every 25 hours or 30 days in salt water areas.

⚠CAUTION

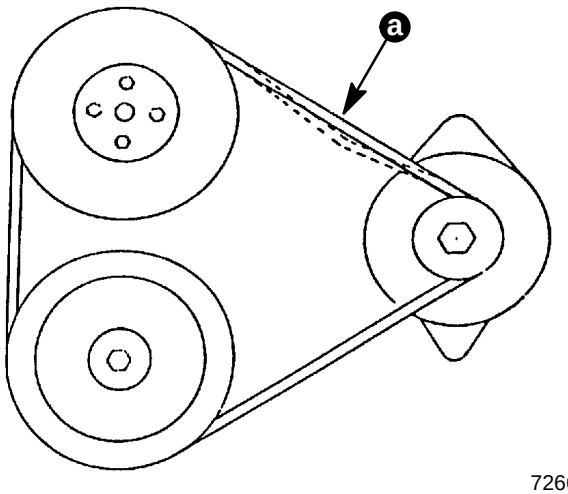
Remove all battery cables from battery (before conducting the following check) to prevent accidentally shorting out electrical system.

1. Inspect entire alternator system for corroded or loose connectors.
2. Check wiring for frayed or worn insulation.
3. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces. Also, check drive belt tension and adjust, if necessary, as explained under “Drive Belt Tension Adjustment.”
4. Check alternator mounting bolts for adequate tightness.
5. Inspect slip ring end frame flame arrestor screen for debris and clean, if necessary, using compressed air or a cloth. Screen MUST BE clean, or alternator may overheat.

Drive Belt Tension Adjustment

V-Belt

1. Install drive belt on pulleys and adjust tension as follows:
   a. Pivot alternator away from engine, as required, until correct tension is obtained as shown. Belt should depress 1/4 in. (6 mm).



72669

V-Belt Drive System

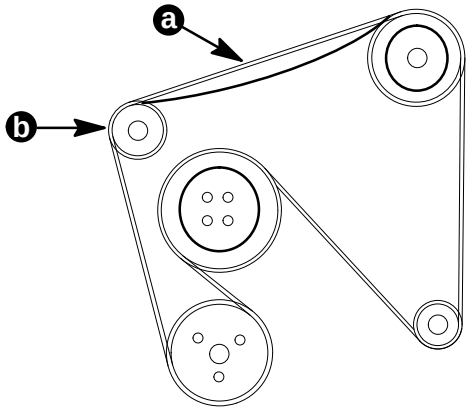
a - Check Point - 1/4 Inch Deflection

   b. After obtaining correct tension. Securely re-tighten alternator brace attaching bolts and alternator mounting bolts.
2. If a new drive belt has been installed, recheck belt tension after running for five minutes.

Serpentine Belt

1. Loosen 5/8 Inch locking nut on adjustment stud. Leave wrench on adjustment stud.
2. Use a 5/16 Inch socket and tighten adjusting stud until the correct deflection (1/4 Inch) is obtained.

NOTE: *Belt deflection should be measured at the longest distance between two pulleys. This distance may vary depending on the particular power package installation.*



Serpentine Belt System

a - Check Point - 1/4 Inch Deflection
b - Idler Pulley

3. While holding adjustment stud at the correct belt tension, tighten the 5/8 inch locking stud.
4. If a new drive belt has been installed, recheck belt tension after running for five minutes.

Troubleshooting Tests (Alternator on Engine)

Use the following tests in conjunction with the “Troubleshooting” in Section 1. Before proceeding with the tests, however, perform the following checks to eliminate possible problem areas. Also observe “Precautions,” preceding, to prevent damage to alternator system.

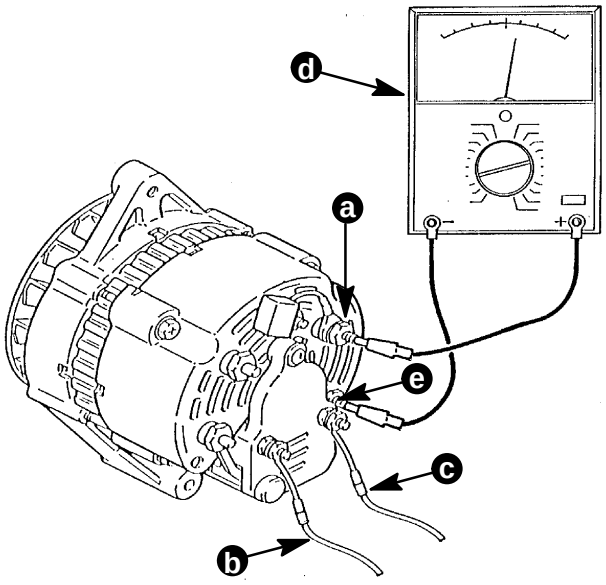
1. If problem is an undercharged battery, check to ensure that undercharged condition has not been caused by excessive accessory current draw or by accessories which have accidentally been left on. Also, check that undercharged condition has not been caused by running engine at too low a speed for extended periods of time.
2. Check physical condition and state of charge of battery, as outlined in “Battery - Storage” in Section 4A. Battery MUST BE at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery before testing system.
3. Inspect entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly battery cable clamps and battery terminals.
4. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces and replace if necessary. Also, check drive belt tension and adjust if necessary, as outlined under “Drive Belt Tension Adjustment.”

Circuitry Test

Perform the following tests, using a 0-20 volt DC voltmeter, to check that all of the circuits between the alternator and the other components within the alternator system are in good condition.

OUTPUT CIRCUIT

1. Connect positive (+) voltmeter lead to alternator output terminal and negative (–) lead to a ground terminal on alternator.
2. Wiggle engine wiring harness while observing voltmeter. Meter should indicate approximate battery voltage and should not vary. If no reading is obtained, or if reading varies, check alternator output circuit for loose or dirty connections or damaged wiring.

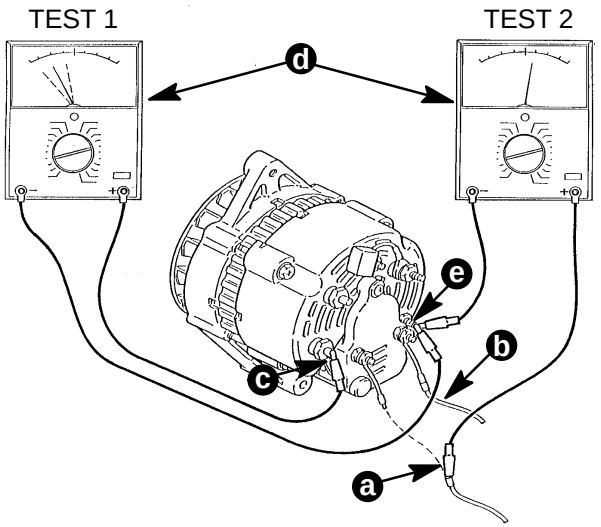


a - Output Wire - ORANGE
b - Excitation Wire - PURPLE
c - Sensing Wire - RED/PURPLE
d - Voltmeter (0-20 Volts)
e - Ground

EXCITATION CIRCUIT

1. Connect positive (+) voltmeter lead to tie strap terminal on alternator and negative (–) lead to a ground terminal on alternator (Test 1).
2. Turn ignition switch to ON position and note voltmeter reading. Reading should be 1.3 to 2.5 volts.
3. If no reading is obtained, an opening exists in alternator excitation lead or in excitation circuit of regulator. Unplug PURPLE lead from regulator. Connect positive voltmeter lead to PURPLE lead and negative voltmeter leads to ground (Test 2). If voltmeter now indicates approximate battery voltage, voltage regulator is defective and must be replaced. If no voltage is indicated, check excitation circuit for loose or dirty connections or damaged wiring.

4. If reading is between .75 and 1.1 volts, rotor field circuit probably is shorted or grounded. Disassemble alternator and test rotor as outlined under “Alternator Repair,” following.
5. If reading is between 6.0 and 7.0 volts, rotor field circuit probably is open. Remove regulator and inspect for worn brushes or dirty slip rings. Replace brushes if less than 1/4 in. (6 mm) long. If brushes and slip rings are in good condition, disassemble and perform rotor test as outlined under “Component Testing - Rotor” following.

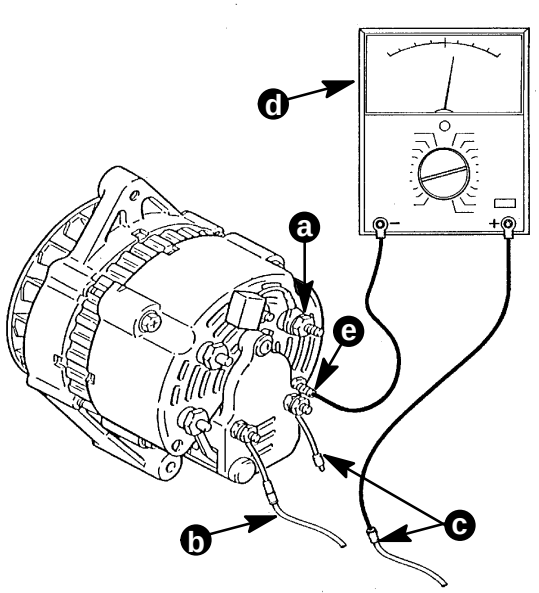


72785

a - Excitation Wire - PURPLE
b - Sensing Wire - RED/PURPLE
c - Tie Bar
d - Voltmeter (0-20 Volts)
e - Ground

SENSING CIRCUIT

1. Unplug RED/PURPLE lead from voltage regulator.
2. Connect positive (+) voltmeter lead to red/purple lead and negative (–) voltmeter lead to ground terminal.
3. Voltmeter should indicate battery voltage. If battery voltage is not present, check sensing circuit (red/purple lead) for loose or dirty connection or damaged wiring.



72786

a - Output Wire - ORANGE
b - Excitation Wire - PURPLE
c - Sensing Wire - RED/PURPLE
d - Voltmeter (0-20 Volts)
e - Ground

Current Output Test

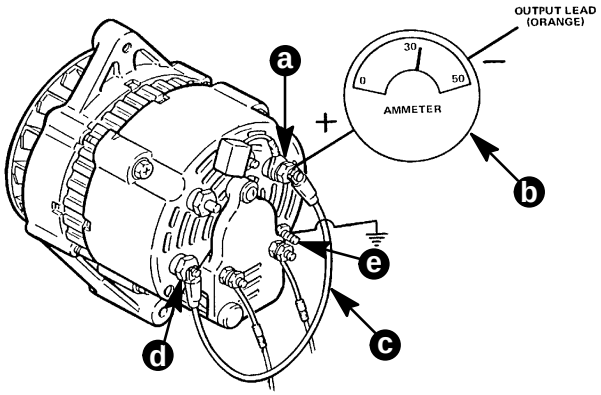
Perform this test to check if alternator is capable of producing rated current output, using a 0-50 amp DC ammeter.

⚠ WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the test) to prevent the possibility of an explosion and/or a fire, should a spark occur.

1. Disconnect negative (–) battery cable from battery.
2. Disconnect orange lead from alternator output terminal and connect ammeter in series between lead and output terminal. Connect positive (+) side of ammeter toward output terminal.
3. Reconnect negative battery cable.
4. Remove coil wire from distributor cap tower and ground it to block. Turn on all accessories and crank engine over with starter motor for 15-20 seconds.

5. Turn off accessories and reinstall coil wire. Start engine and adjust engine speed to 1500-2000 RPM. Quickly observe ammeter. Reading should be at least 30 amps.
6. If reading is low, stop engine and connect a jumper wire between alternator output terminal and regulator terminal. Repeat Steps 4 and 5.
7. If reading is now within specifications, diodes are faulty. Disassemble alternator and replace rectifier as explained under “Alternator Repair,” following, to determine if fault is in regulator or alternator.
8. If reading is still low with jumper wire connected, perform “Voltage Output Test,” following, to determine if fault is in regulator or alternator.



72787

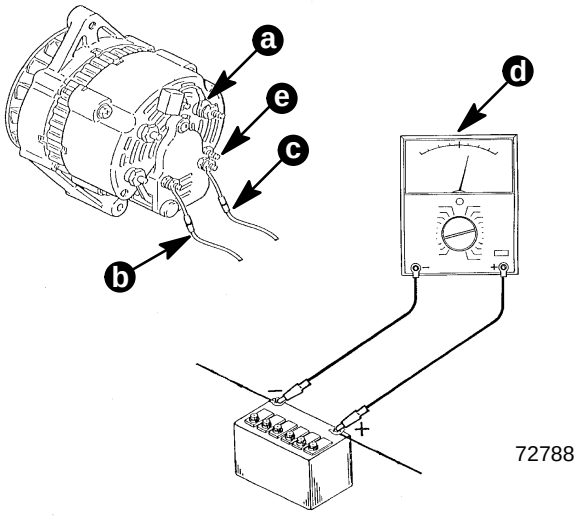
a - Output Wire - ORANGE
b - Ammeter (0-50 Amps)
c - Jumper Lead
d - Regulator Lead
e - Ground

Voltage Output Test

Perform this test to determine if voltage regulator is operating correctly, using a 0-20 volt DC voltmeter.

IMPORTANT: Battery MUST BE fully charged (1.260 or above specific gravity) to obtain proper voltage reading in this test. If necessary, charge battery with a battery charger or allow engine to run a sufficient length of time to fully charge battery before taking reading.

1. Connect positive (+) voltmeter lead to positive battery terminal and negative (–) voltmeter lead to negative terminal.
2. Start engine and run at fast idle until engine reaches normal operating temperature. Adjust engine speed to 1500-2000 RPM and observe voltmeter for highest reading. Reading should be between 13.9 and 14.7 volts.
3. If reading is high, check for a loose or dirty regulator ground lead connection. If connection is good (and sensing circuit checked out good in “Circuitry Test”), voltage regulator is faulty and must be replaced. Be sure to disconnect battery cables before attempting to remove regulator.



72788

a - Output Wire - ORANGE
b - Excitation Wire - PURPLE
c - Sensing Wire - RED/PURPLE
d - Voltmeter (0-20 Volts)
e - Ground

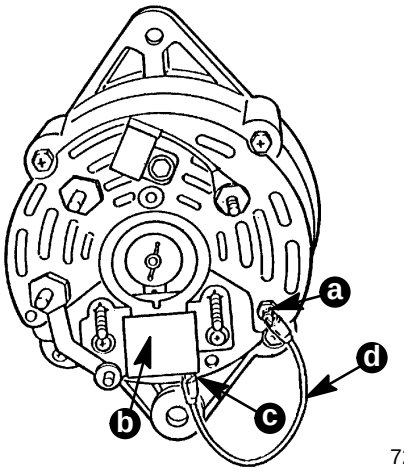
⚠ WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the next steps) to prevent the possibility of an explosion and/or fire, should a spark occur.

⚠ CAUTION

DO NOT allow tie jumper wire to contact alternator end frame (in next step), as rectifier and diode assembly may be damaged.

4. Remove four nuts holding excitation and sensing wires and Phillips screw. Remove regulator cover and install wires and nuts for testing. Connect a jumper wire from the ground stud to the brush terminal on the lower right- hand side of the brush assembly. Restart engine and gradually increase engine speed to 1500 RPM while observing voltmeter. DO NOT allow voltage to exceed 16 volts.
5. If a voltmeter reading of 14.5 volts or above is now obtained, voltage regulator is faulty and must be replaced. If voltmeter reading is below 14.5 volts, inspect brushes and slip rings for wear, dirt or damage. If brushes and slip rings are good, alternator is faulty internally. Disassemble alternator and test components, as outlined under “Alternator Repair,” following.



72971

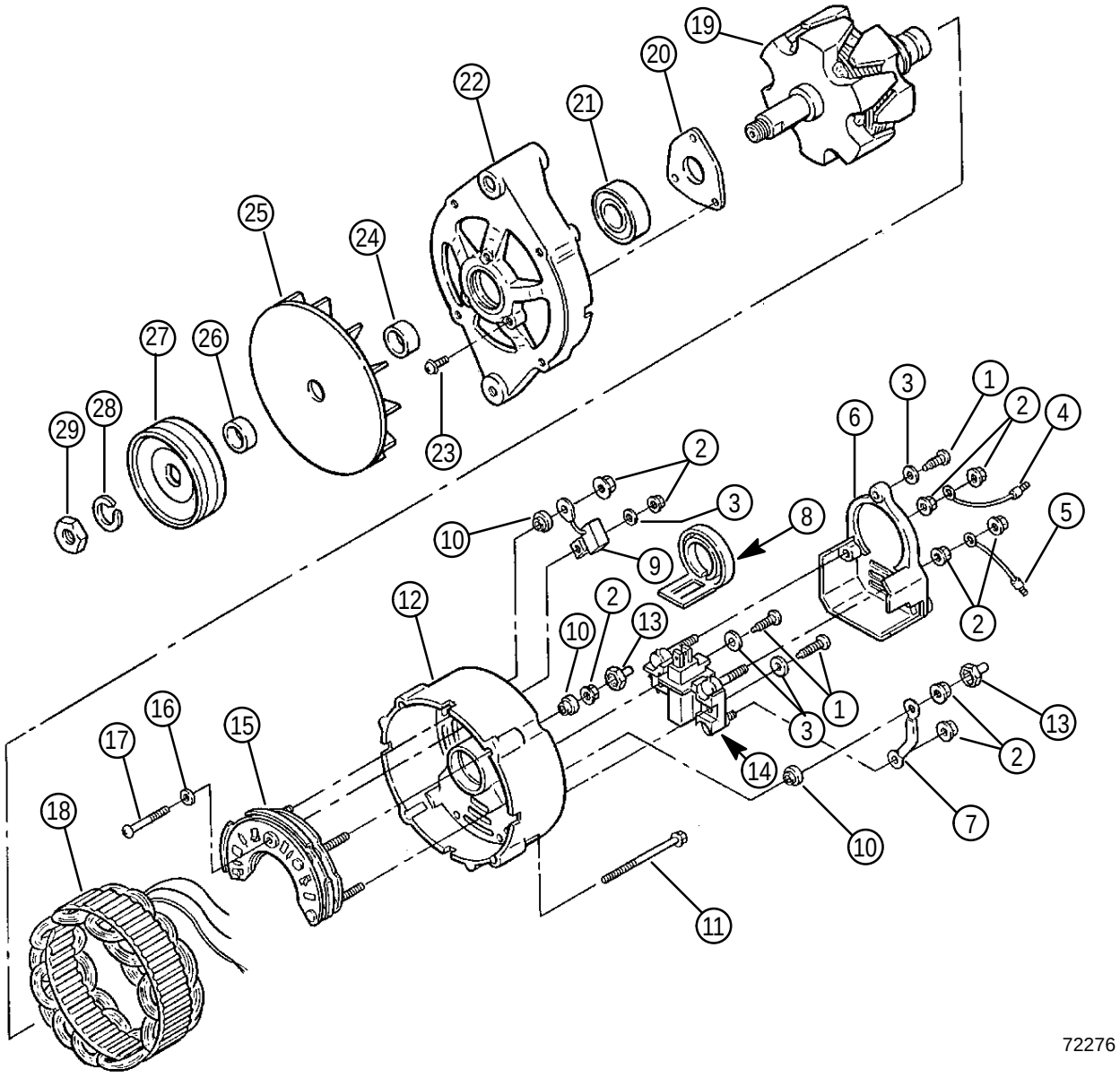
a - Ground
b - Brush / Regulator Assembly
c - Brush Terminal
d - Jumper Wire (Solder Connection Ground)

Alternator Repair

Removal

1. Disconnect negative (–) battery cable from battery.
2. Disconnect wiring harness from alternator.
3. Remove alternator brace-to-alternator attaching bolt, washer(s) and spacer (if used).
4. Loosen alternator brace-to-engine attaching bolt and alternator mounting bolt, then pivot alternator inward and remove alternator drive belt.
5. Remove alternator mounting bolt, washers (if used), spacer and nut, and remove alternator.

Exploded View



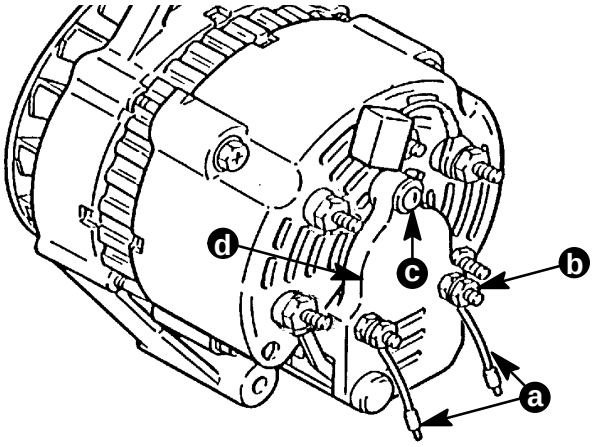
1 - Rectifier Assembly
2 - Flat Washer
3 - Screw
4 - Stator
5 - Rotor And Slip Ring
6 - Retaining Plate
7 - Front Bearing
8 - End Frame (Front)
9 - Screw (3)
10 - Fan Spacer
11 - Fan
12 - Pulley Spacer
13 - Pulley
14 - Lockwasher
15 - Nut
16- Screws (3)
17- Nut (9)
18- Flat Washer (4)
19- Sensing Wire (RED / PURPLE)
20- Excitation Wire (PURPLE)
21- Cover
22- Tie Strap
23- Rubber Gasket
24- Condenser
25 - Insulator
26- Bolt (4)
27 -End Frame (Rear)
28 - Cap (2)
29 - Brush / Regulator Assembly

Index

Disassembly

IMPORTANT: The following instructions are for complete disassembly and overhaul of the alternator. In many cases, however, complete disassembly of alternator is not required and, in those cases, it is necessary only to perform the operations required to repair or replace the faulty part.

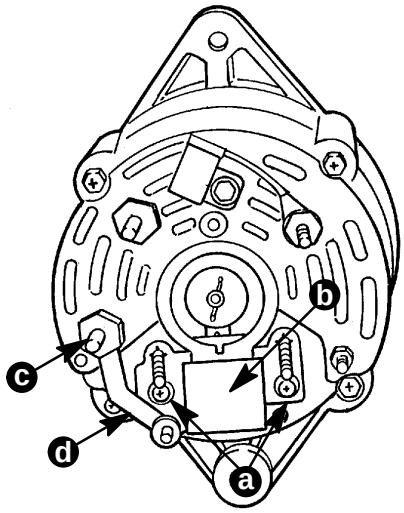
1. Mount alternator in a vise so that rear end frame is facing you.
2. Disconnect regulator leads from terminals on rear end frame. Remove four nuts, Phillips head screw and two regulator leads. Then pull regulator cover away from rear end frame.



72963

a - Regulator Leads
b - Nuts (4)
c - Phillips Head Screw
d - Regulator Cover

3. Remove stud cover insulator, two nuts and tie strap from brush/regulator assembly.
4. Remove two brush/regulator attaching screws and remove brush/regulator assembly.



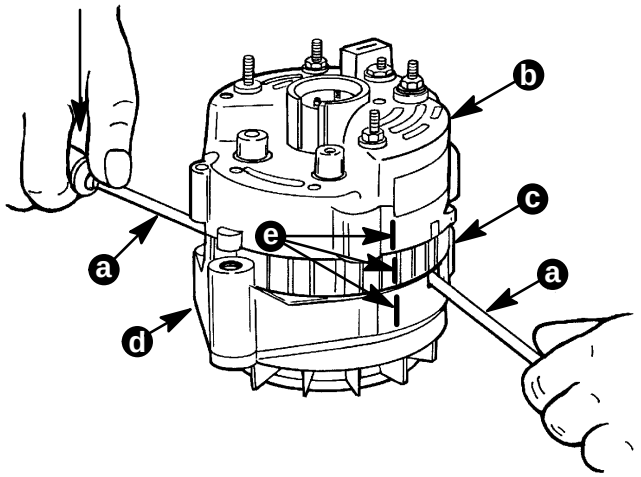
72823

a - Screws
b - Brush / Regulator Assembly
c - Stud Cover Insulator
d - Tie Strap

5. Scribe a mark on rear end frame, stator and front end frame to ensure proper reassembly later.
6. Remove four screws which secure end frames and stator together.

IMPORTANT: DO NOT insert screwdriver blades more than 1/16 in. (1.5 mm) into openings (in next step), as stator windings may be damaged.

7. Separate rear end frame and stator assembly from front end frame and rotor assembly using two thin blade screwdrivers (positioned 180 degrees apart from one another) at the locations shown. Use the two slots shown to initially separate
units.

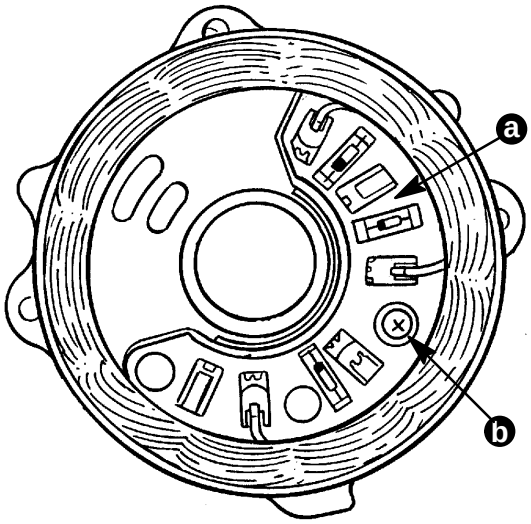


72824

a - DO NOT Insert Screwdriver Blades More Than 1/16 In. (1.5 mm) Into Slots.
b - Rear End Frame
c - Stator
d - Front End Frame
e - Scribe Marks

8. Place rear end frame and stator assembly on the bench with stator downward. Be sure that bench is clean and free of metal chips. Remove nuts, washers, insulators and condenser from output and ground studs.

9. Turn end frame over (stator upward) and remove one Phillips head screw which secures rectifiers to end frame.

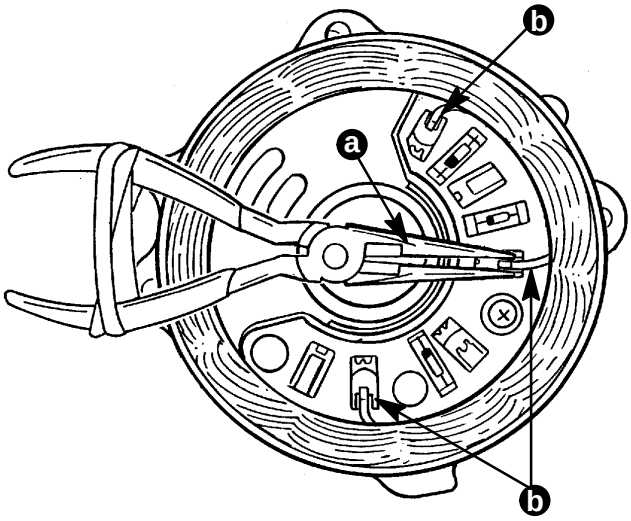


72826

a - Rectifier Assembly
b - Phillips Head Screw

10. Separate stator and rectifier assembly from rear end frame using screwdriver slots.

11. Unsolder the three stator leads from the rectifier heat sink. Place a needle nose pliers on diode terminal between solder joint and diode body to help prevent heat damage to diodes. Unsolder joints as quickly as possible and allow diode terminal to cool before removing pliers.



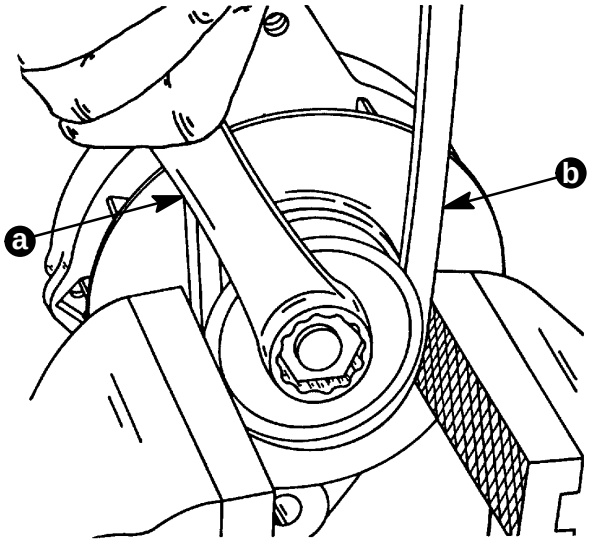
72827

a - Heat Sink
b - Stator Leads (3)

IMPORTANT: With alternator disassembled to this point, stator, rectifier, diodes, and rotor may be tested, as explained under "Component Testing," following.

IMPORTANT: DO NOT clamp vise on rotor pole pieces when removing pulley nut (in next step), as pole pieces may be distorted.

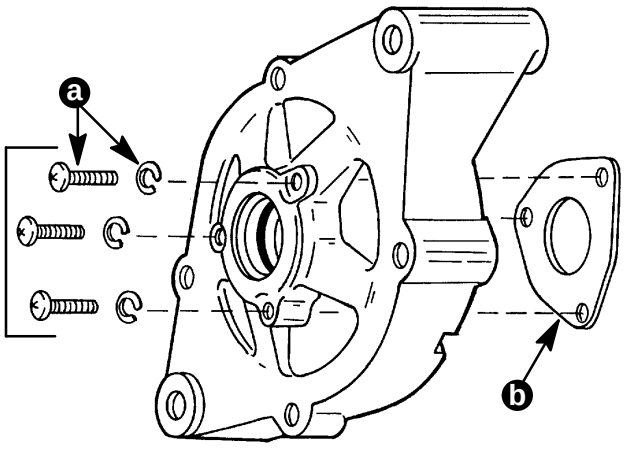
12. Remove pulley retaining nut by clamping pulley in a vise (using an oversize V-belt or protective jaws to protect pulley) and turning nut counterclockwise with a wrench. Remove lockwasher and slide pulley and fan from shaft. If pulley is difficult to remove, it may be necessary to use a universal puller.



72828

a - Wrench
b - Over-Sized Belt To Protect Pulley

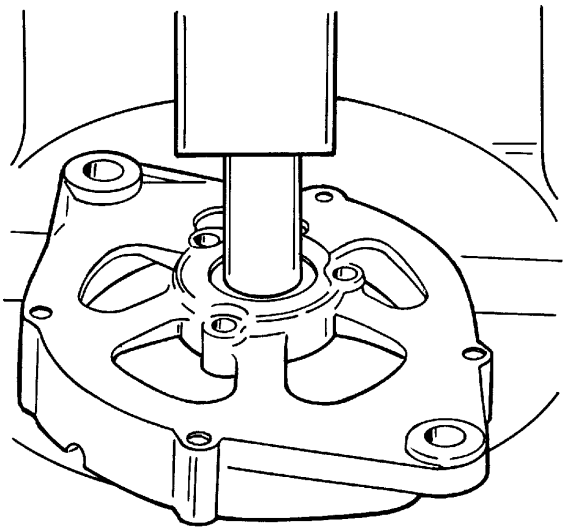
13. Remove the three Phillips head screws and lockwashers which secure the front bearing retaining plate.



72829

a - Phillips Head Screws and Lockwashers
b - Front Bearing Retaining Plate

14. Remove front bearing from front end frame using an arbor press and a suitable size mandrel. (Discard bearing.)



72830

Removing Front Bearing from Front End Frame

15. If rotor slip rings or rear bearing requires replacement, entire rotor must be replaced. Parts cannot be purchased separately.

Cleaning and Inspection

1. Clean all parts with a clean, soft cloth. DO NOT use solvent, or electrical components may be damaged.
2. Inspect the following parts for wear and damage:

a. **Brush/regulator assembly** - inspect for cracked casing, damaged brush leads, poor brush lead solder connections, weak or broken brush springs or worn brushes. Replace brush set if brushes are less than 1/4 in. (6 mm) long.

b. **Rotor** - inspect for stripped threads, scuffed pole piece fingers or damaged bearing surfaces (because of bearing turning on shaft).

c. **Rotor-slip rings** - clean slip rings with 400 grain (or finer) polishing cloth while spinning rotor in a lathe. Blow off dust with compressed air. Inspect slip rings for grooves, pits, flat spots or out-of-round [.002 in. (0.051 mm) maximum] and replace rotor, if present.

d. **Rotor shaft and front end bearings** - inspect for damaged seals, lack of lubrication, discoloration (from overheating) and excessive side or end play. Bearing should turn freely without binding or evidence of rough spots.

e. **Stator** - inspect for damaged insulation or wires; also inspect insulating enamel for heat discoloration, as this is usually a sign of a shorted or grounded winding or a shorted diode.

f. **Front and rear end frames** - inspect for cracks, distortion, stripped threads or wear in bearing bore (from bearing outer race spinning in bore). End frame(s) MUST BE replaced, if bearing has spun. Also, inspect bearing retainer recess in front end frame for damage.

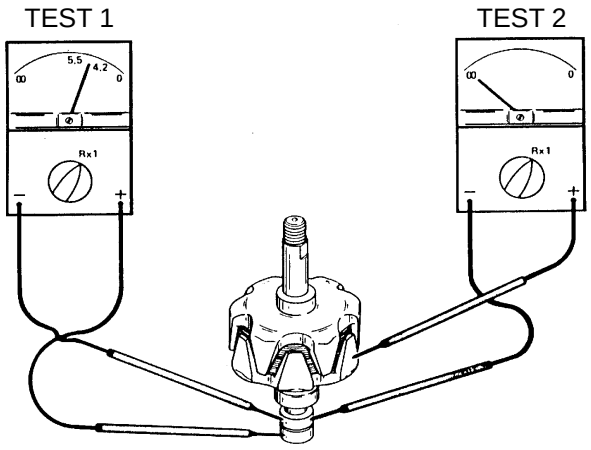
g. **Fan** - inspect for cracked or bent fins, broken welds (bi-rotational fan only) or worn mounting hole (from fan spinning on shaft).

h. **Pulley** - inspect pulley mounting bore end for wear. Inspect drive surface of pulley sheaves for trueness, excessive wear, grooves, pits, nicks and corrosion. Repair damaged surfaces, if possible, with a fine file and a wire brush or replace pulley, if beyond repair. Drive surfaces MUST BE perfectly true and smooth or drive belt wear will be greatly accelerated.

Component Testing

ROTOR

1. Test rotor field circuit for opens, shorts or high resistance (Test 1), using an ohmmeter (set on R x1 scale), as follows:



72831

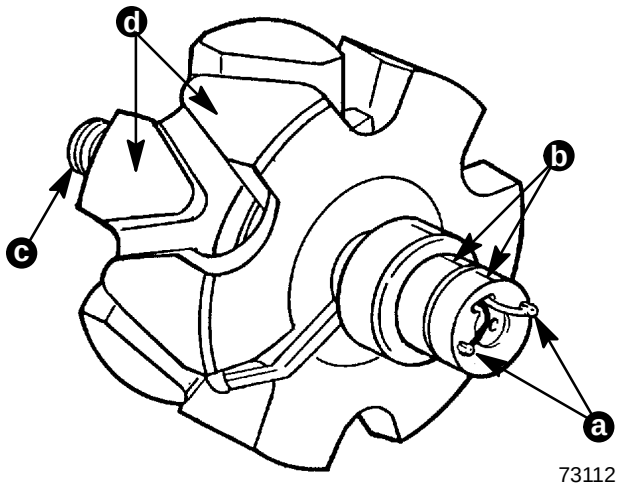
Testing Rotor Field Circuit

   a. Connect one ohmmeter lead to each slip ring.

   b. Ohmmeter reading should be 4.2 to 5.5 ohms with rotor at room temperature 70-80°F (21-26°C).

   c. If reading is high or infinite (no meter movement), high resistance or an open exists in the field circuit. Check for poor connections between field winding leads and slip ring terminals. If cause for open or high resistance cannot be found, connect ohmmeter directly to slip ring terminals. If correct reading is now obtained, or if reading is still high or infinite, replace complete rotor assembly.

d. If reading is low, a short exists in the field circuit. Inspect slip rings to be sure that they are not bent and touching outer slip ring. Also, be sure that excess solder is not shorting terminals to aft slip ring. If cause for short cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter directly to leads. If correct reading is now obtained, or if reading is still low, slip rings and rotor field windings are shorted, and complete rotor assembly must be replaced.



73112

a - Field Winding Leads
b - Slip Rings
c - Rotor Shaft
d - Pole Pieces

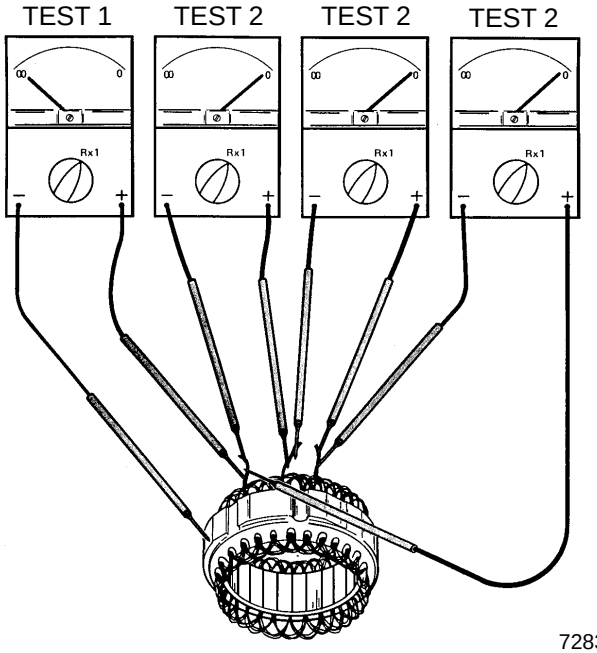
2. Test rotor field circuit for grounds (Test 2), using an ohmmeter (set on R x1 scale) as follows:
   a. Connect one lead of ohmmeter to either slip ring and the other lead to rotor shaft or pole pieces.
   b. Meter should indicate no continuity (meter should not move).
   c. If continuity does exist, complete rotor assembly must be replaced.

IMPORTANT: If alternator has output at low speeds, but no output at high speeds, rotor field winding may be shorting or grounding out, due to centrifugal force. Replace rotor if all other electrical components test good.

STATOR

IMPORTANT: Stator leads MUST BE disconnected from rectifier for this test.

1. Test stator for grounds (Test 1), using an ohmmeter (set on R x1 scale) as follows:
   a. Connect one lead of ohmmeter to one of the stator leads and the other lead to stator frame. Be sure that lead makes good contact with frame.
   b. Meter should indicate no continuity (meter should not move). If continuity does exist, stator is grounded and must be replaced.
2. Test for opens in stator (Test 2), using an ohmmeter (set on R x1 scale) as follows:
   a. Connect ohmmeter between each pair of stator windings (three different ways).
   b. Continuity should be present in all three cases (meter should move). If it does not, one or more of the windings are open and stator must be replaced.



72833

Testing Stator

3. A short in the stator is difficult to detect without special equipment, because of the low windings resistance. If all other electrical components test out good, and alternator fails to produce rated output, stator probably is shorted and should be replaced. Also, examine stator for heat discoloration, as this usually is a sure sign of a short.

RECTIFIER AND DIODE ASSEMBLY

NOTE: *Failure of any component in tests following will require replacement of entire rectifier assembly.*

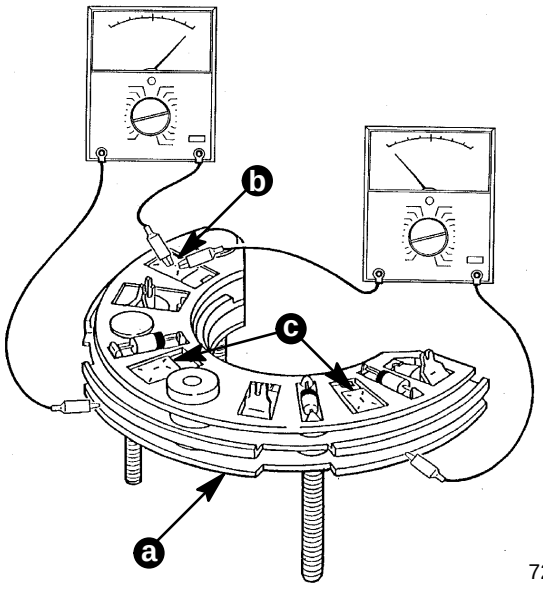
NEGATIVE (–) RECTIFIER

IMPORTANT: Rectifier MUST BE disconnected from stator for this test.

⚠CAUTION

DO NOT use a test instrument with more than a 12 volt source (in the following test), as rectifier may be damaged.

1. Connect one lead of an ohmmeter (set on R x1 scale) to negative (–) rectifier heat sink and the other lead to one of the rectifier terminals. Note the reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, rectifier is open. If both readings are low, rectifier is shorted.
4. Repeat Steps 1 through 3 for two other rectifiers in heat sink.
5. Replace assembly if any of the rectifiers is shorted or open.



72147

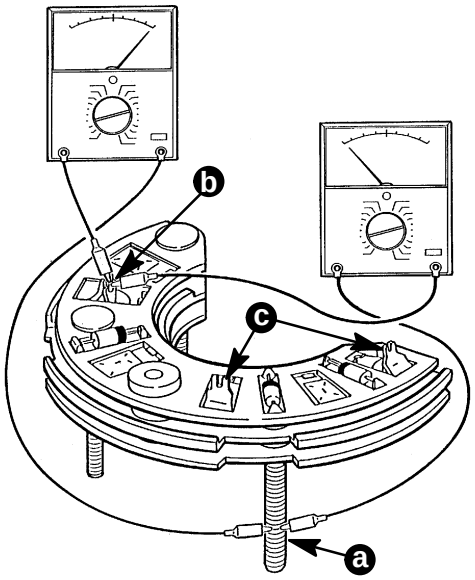
a - Heat Sink
b - Rectifier Terminal
c - Test These Two Rectifiers In The Same Manner

POSITIVE (+) RECTIFIER AND DIODES

⚠CAUTION

DO NOT use a test instrument with more than a 12 volt source (in the following test), as rectifier may be damaged.

1. Connect one lead of an ohmmeter (set on R x1 scale) to 1/4 in. stud on positive (+) rectifier heat sink and the other lead to one of the rectifier terminals. Note the meter reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, rectifier is open. If both readings are low, rectifier is shorted.
4. Repeat Steps 1 through 3 for two other rectifiers in heat sink.

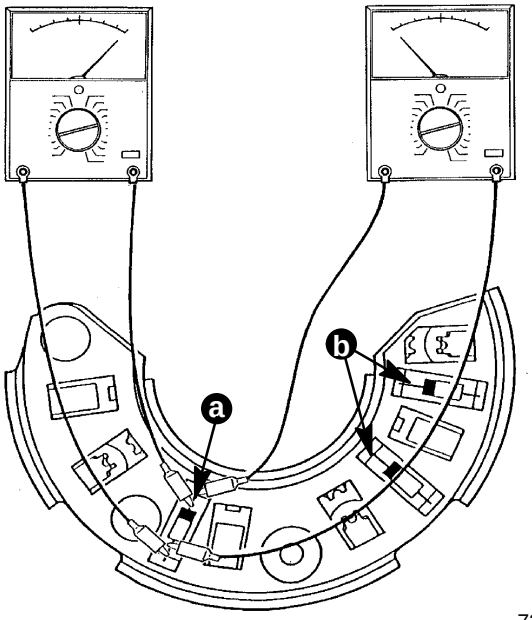


72834

a - Stud
b - Rectifier Terminal
c - Repeat Test Between These Terminals And Stud

5. Replace assembly if any one of the rectifiers is shorted or open.

6. Connect one lead of an ohmmeter (set on R x1) to the common side of the diode and the other lead to the other side, of one of the three diodes.



72148

a - Common Side Of Diode Circuit Board
b - Repeat Test For Two Diodes

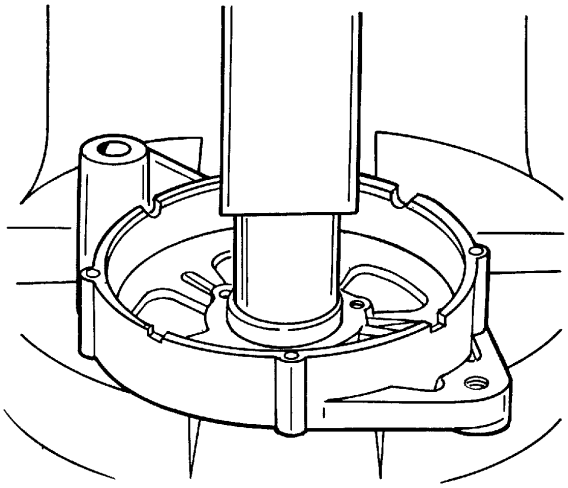
7. Reverse leads and again note reading.
8. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, diode is open. If both readings are low, diode is shorted.
9. Repeat Steps 6 through 8 for the other two diodes.
10. Replace rectifier assembly if any one of the diodes is shorted or open.

CONDENSER

1. Using magneto analyzer and accompanying instructions, perform the following condenser tests:
   a. Condenser Capacity Test (must be .5 mfd).
   b. Condenser Short or Leakage Test.
   c. Condenser Series Resistance Test.
2. Replace condenser if test results are not within specifications.

Reassembly

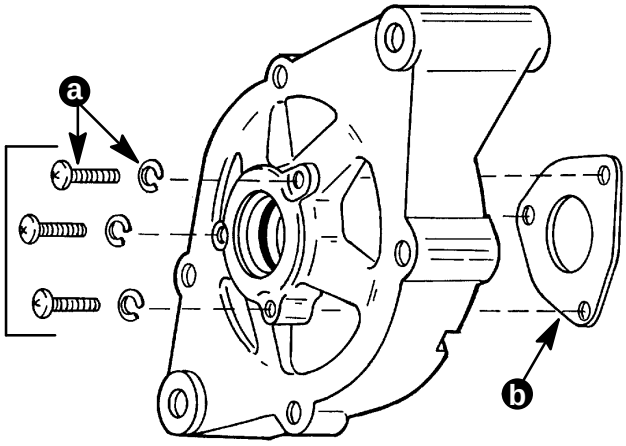
1. Install new front bearing into front end frame bearing bore using an arbor press. If necessary, use a bearing driver that contacts outer race only.



72835

Installing Front Bearing into Front End Frame

2. Install front bearing retaining plate using three Phillips head screws and lockwashers.



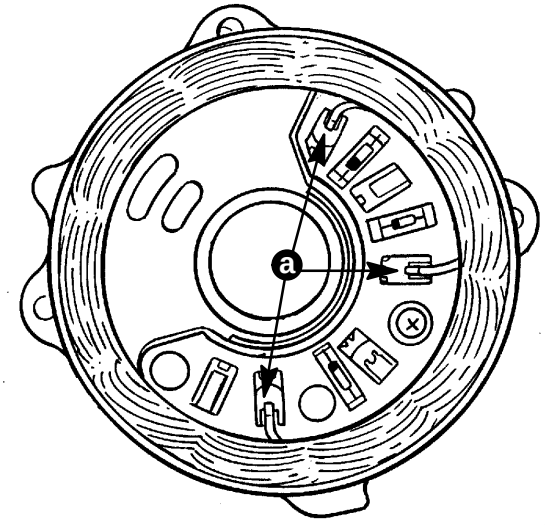
72829

a - Phillips Head Screws And Lockwashers
b - Front Bearing Retaining Plate

3. Slide front end frame over rotor.

IMPORTANT: DO NOT clamp vise on rotor pole pieces when tightening pulley nut (in next step), or pole pieces may be distorted.

4. Slide fan spacer onto rotor shaft. Install fan, pulley, lockwasher and nut on shaft. Clamp pulley in a vise, using protective jaws or an old oversize V-belt to protect pulley, and torque nut to specifications. Tighten vise only enough to allow tightening of nut, as excessive tightening may distort pulley.
5. Assemble stator to rectifier by soldering the three leads to the three rectifier terminals.



72826

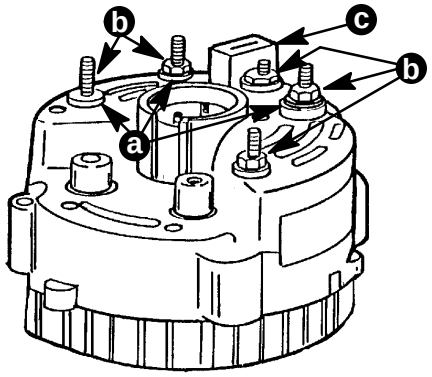
a - Stator Lead Connections

NOTE: *Be sure to connect leads to their original positions.*

6. Install assembled stator and rectifier assembly into rear end frame, aligning scribe marks on each (scribed during disassembly), and install Phillips head screw and washer to retain.

IMPORTANT: The insulating washers MUST BE installed as shown or damage to the alternator will result.

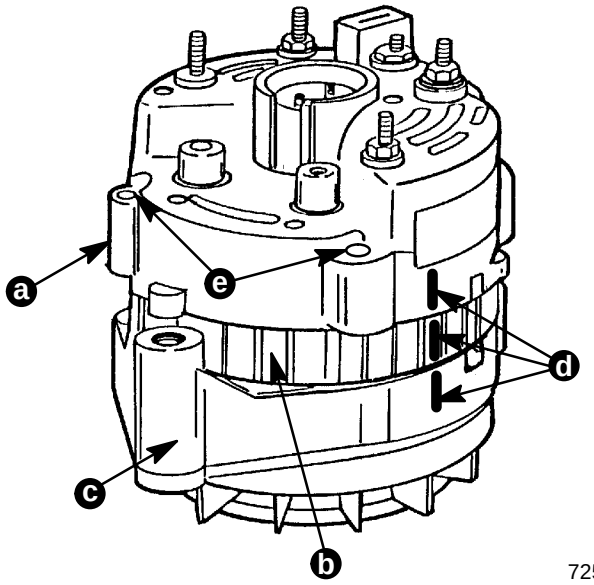
7. Position stator down with rear end frame up and reinstall insulators, nuts and condenser.



72561

a - Insulators (3)
b - Nuts (5) - ONE REMOVED
c - Condenser

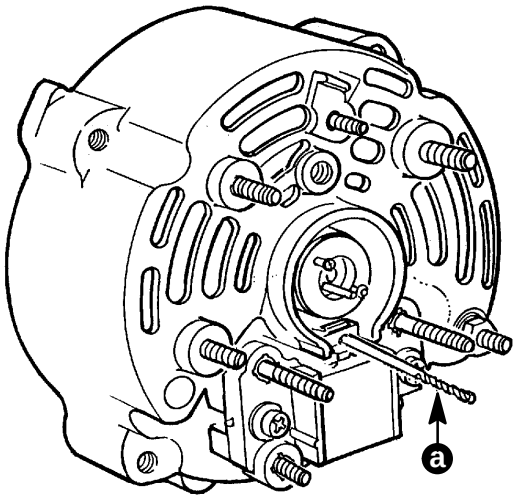
8. Position rear end frame and stator assembly over front end frame and rotor assembly and align scribe marks on each (scribed during disassembly). Hand-press end frames together, then install four screws. Tighten screws securely.



72561

a - Rear End Frame
b - Stator
c - Front End Frame
d - Scribe Marks
e - Insert Screws (4) (Two Hidden)

9. Depress brushes flush with top of brush holder and insert a #54,.050 in. drill bit or smaller into hole in brush holder to hold brushes compressed during reassembly.

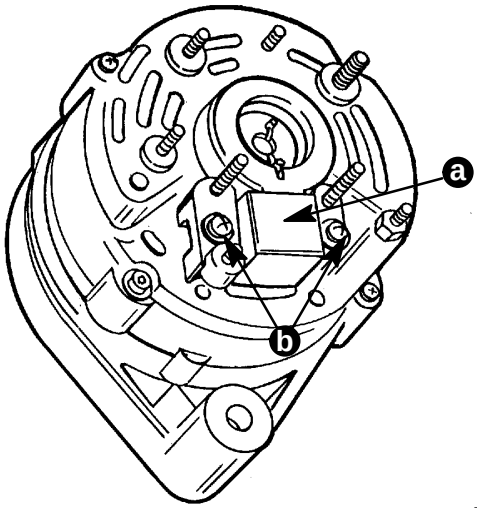


72836

a - Drill Bit

NOTE: *Rubber gasket shown removed for clarity.*

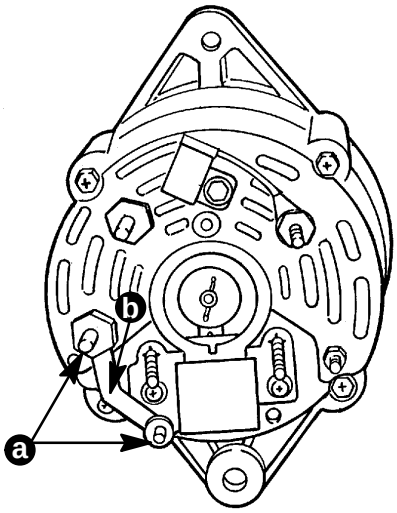
10. Install brush/regulator assembly in rear end frame cavity and secure with two mounting screws, as shown. Tighten screws securely. Remove drill bit to release brushes against slip rings.



72837

a - Brush / Regulator Assembly
b - Mounting Screws

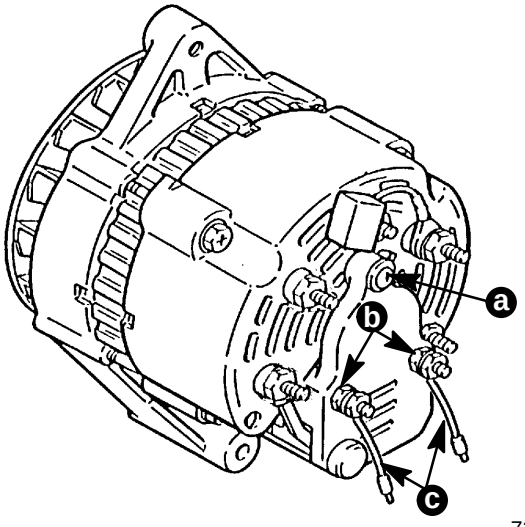
11. Install tie strap to rectifier stud and stud on brush/rectifier assembly. Tighten nuts securely.



72823

a - Studs
b - Tie Straps

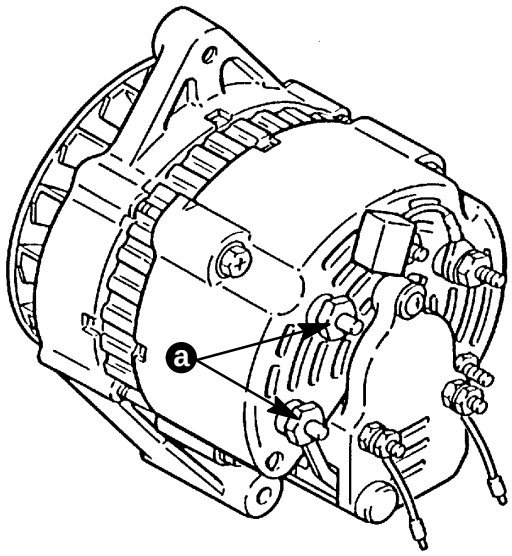
12. Install cover with one Phillips head screw and two nuts. Install two leads with nuts.



72963

a - Phillips Head Screw
b - Nuts (4)
c - Leads

13. Install insulator caps.

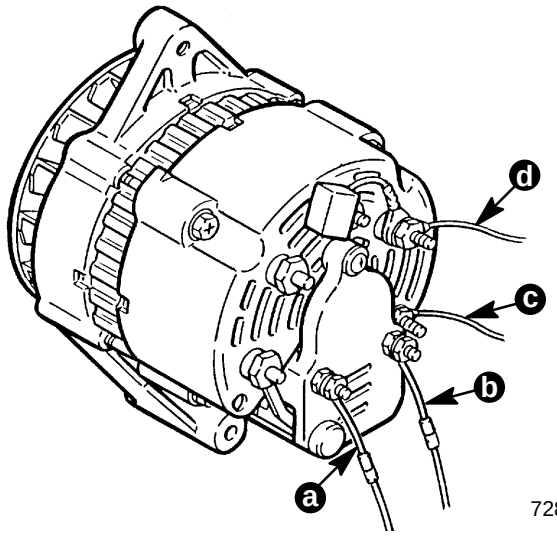


72078

a - Insulator Caps

Installation

1. Position alternator in mounting bracket and install mounting bolt, washers (if used), spacer and nut. Place washers (if used), on each side of spacer. DO NOT tighten securely at this time.
2. Fasten alternator brace to alternator with bolt, washers and spacer (if used). DO NOT tighten bolt at this time.
3. Position alternator drive belt on pulleys and adjust tension as explained under “Drive Belt Tension Adjustment.”
4. Reconnect wiring harness to alternator and negative battery cable to battery.



72838

a - Excitation Lead -(PURPLE)
b - Sensing Lead - (RED / PURPLE)
c - Ground Lead - (BLACK)
d - Output Lead - (ORANGE)

Battery Isolators

Dual Battery Charging Systems Using a Battery Isolator

Battery isolators allow the addition of an auxiliary (second) battery to the MerCruiser electrical system. The auxiliary battery is primarily used as a power source for various accessories installed on the boat. The battery isolator will allow the alternator to charge both the cranking and auxiliary batteries at the same time while preventing accessories, connected to the auxiliary battery, from drawing power from the cranking battery.

Mercury Marine does not manufacture any battery isolator systems. Battery isolators must be bought from an outside manufacturer. Mercury Marine suggests following the manufacturer’s instructions carefully.

IMPORTANT: Alternators used on MerCruiser engines ARE NOT equipped with an isolation diode.

⚠CAUTION

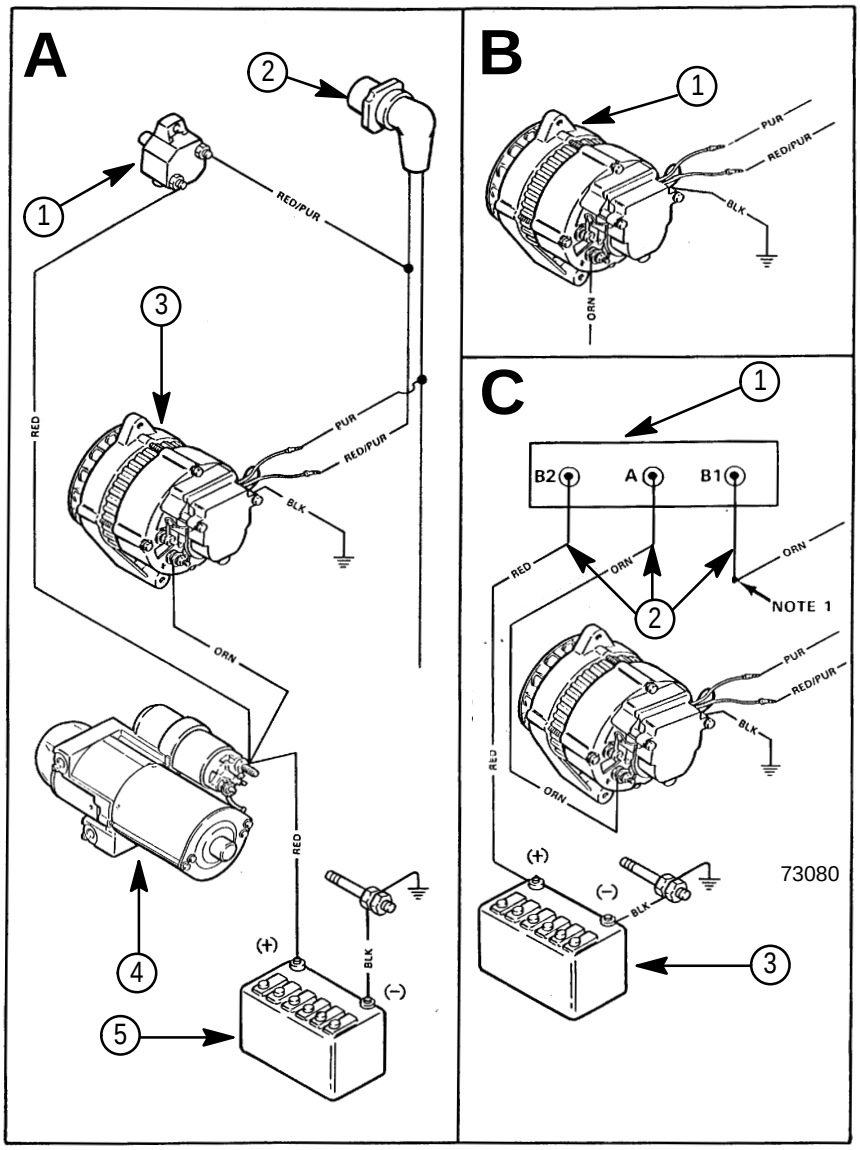
Follow battery isolator manufacturer’s instructions for wire gauge. Battery isolator installation must conform to BIA Low Voltage Wiring Standard No. 125-79.

NOTE: *MerCruiser engines equipped with a 3-wire, belt driven alternator, can use a battery isolator.*

Index

Battery Isolator

BLK	=	BLACK
BLU	=	BLUE
BRN	=	BROWN
GRY	=	GRAY
GRN	=	GREEN
ORN	=	ORANGE
PNK	=	PINK
PUR	=	PURPLE
RED	=	RED
TAN	=	TAN
WHT	=	WHITE
YEL	=	YELLOW
LIT	=	LIGHT
DRK	=	DARK



Alternator with Voltmeter Circuit (Typical Wiring Shown)

Note : Disconnect ORANGE wire from alternator ”Batt” terminal. Splice sufficient length of proper gauge wire and connect as shown.

A - WIRING DIAGRAM

1 - Circuit Breaker
2 - Wiring Harness
3 - Alternator
4 - Starter
5 - Cranking Battery

B - ORIGINAL WIRING

1 - Alternator

C - WIRING CONNECTIONS WITH ISOLATOR

1 - Isolator
2 - Use 8 Gauge Wire Minimum
3 - Auxiliary Battery

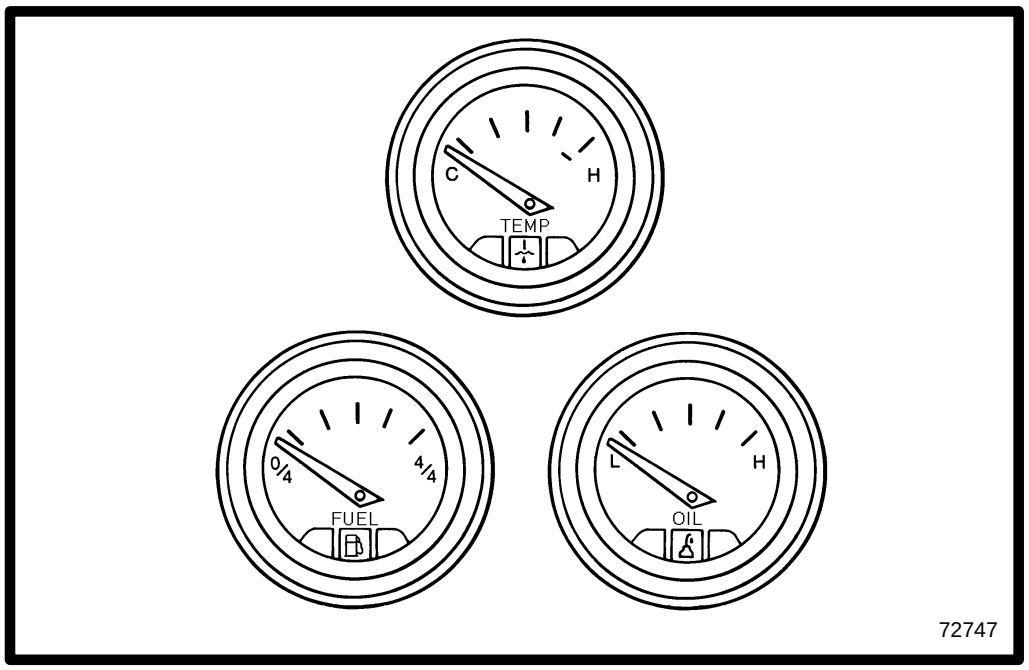
THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

ELECTRICAL SYSTEM

4

D



INSTRUMENTATION

Index

Table of Contents

	Page
Identification	4D-1
Special Information	4D-1
Lighting Options	4D-1
Commodore and International Series	4D-1
QSI Series	4D-2
Gauges	4D-2
Oil, Fuel and Temperature	4D-2
Testing	4D-2
Battery Gauge	4D-3
Testing	4D-3
Cruiselog Meter	4D-4
Testing	4D-4
Vacuum Gauge	4D-4
Testing	4D-4
Speedometer	4D-4
Testing	4D-4
Calibration Chart	4D-4
Tachometer	4D-4
Testing	4D-4
Gauge Replacement	4D-5
Senders	4D-5
Oil Pressure	4D-5
Dual Station Sender Identification	4D-5
Testing	4D-5
Water Temperature	4D-6
Dual Station Sender identification	4D-6
Removal	4D-6
Testing	4D-6
Installation	4D-7
Fuel Tank Sender	4D-7
Flange Type	4D-7
Capsule Type	4D-8
Switches	4D-9
Ignition Key Switch	4D-9
Testing	4D-9
Lanyard Stop Switches	4D-10
Testing	4D-10
Start/Stop Switch	4D-11
Testing	4D-11
Audio Warning System	4D-11
Buzzer	4D-11
Testing	4D-11
Oil Pressure Switch	4D-12
Testing	4D-12
Water Temperature Switch	4D-12
Removal	4D-12
Testing	4D-13
Installation	4D-15

NOTICE

For information and procedures on trouble-shooting, refer to Section 1C.

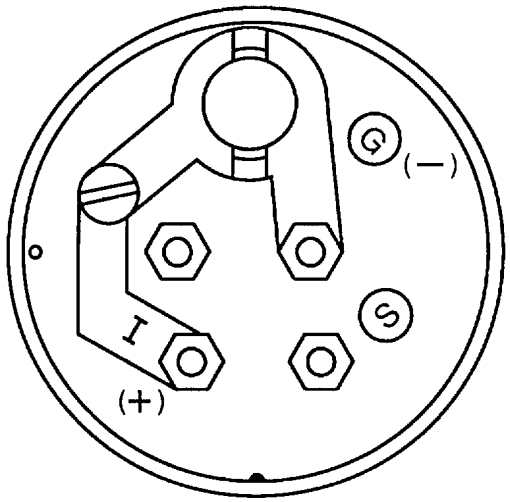
NOTICE

For information and procedures on Fuel Injection Engines, refer to Section 5C.

Index

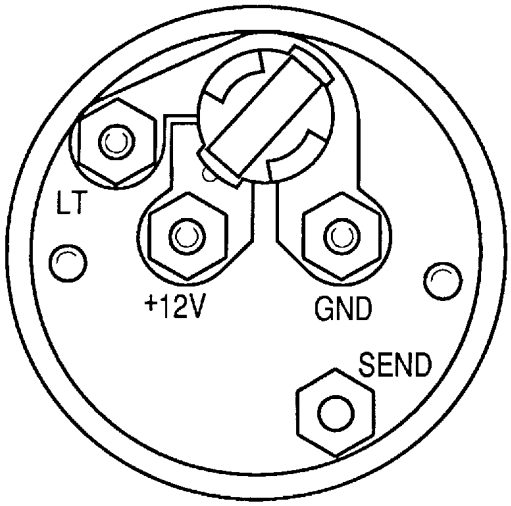
Identification

NOTE: *One of three distinct lines (Series) of Quicksilver gauges may be installed (if equipped with Quicksilver gauges). Aside from different gauge face appearances and styling, the back of the gauges and wiring connections are different as shown.*



72746

Back of Commodore and International Series Gauge - Typical



72965

Back of QSI Series Gauge - Typical

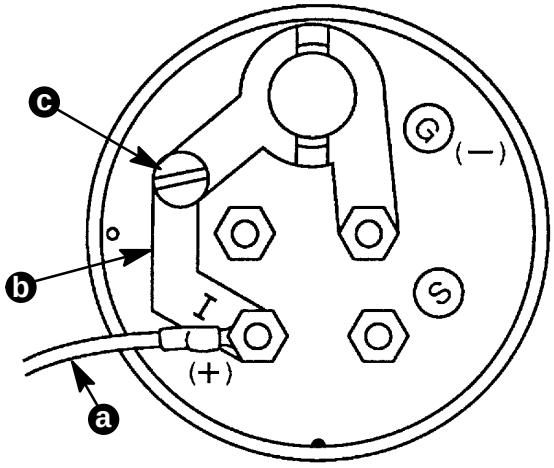
Special Information

Lighting Options

COMMODORE AND INTERNATIONAL SERIES

These gauges may be wired so that the illumination lighting is provided from the ignition switch or a separate instrumentation lighting switch.

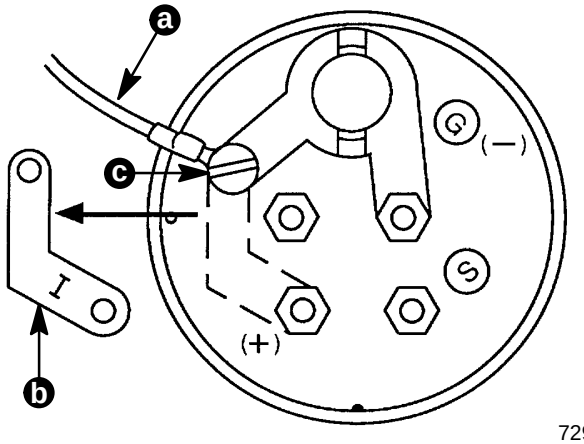
By removing contact strip “I” from between + terminal and the screw as shown following, and supplying a separate +12 V power supply to the screw connection, illumination lights can be operated independent of ignition switch.



72966

Ignition Switch Lighting Circuit

a - Positive (+) 12 Volt Power Supply From Ignition Switch
b - Contact Strip ”I”
c - Screw Connection



72967

Separate Instrumentation Lighting Circuit Wiring

a - Positive (+) 12 Volt Power Supply From Ignition Switch
b - Contact Strip ”I”
c - Screw Connection

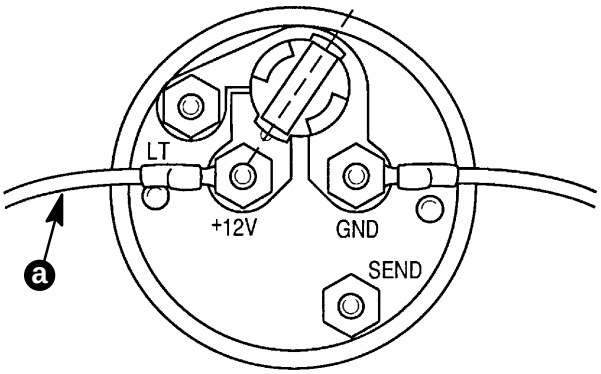
Index

QSI SERIES

These gauges are equipped with optional illumination lighting. Light bulb socket can be removed and contacts can be aligned to be used with ignition switch lighting circuit +12 V or separate instrumentation lighting circuit LT.

IMPORTANT: Light socket must be removed from gauge and turned counterclockwise (facing back of gauge) when adjusting to desired setting. Turning socket while still installed in gauge could result in damage to gauge or socket.

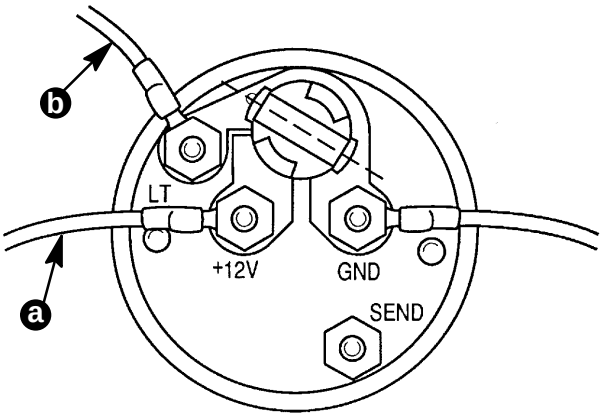
NOTE: *For different lighting effects, colored sleeves are available through the Quicksilver Accessories and can be assembled to the bulb.*



72968

Ignition Switch Lighting Circuit Position

a - Positive (+) 12 Volt Power Supply From Ignition Switch



72969

Separate Instrumentation Lighting Circuit Position

a - Positive (+) 12 Volt Power Supply From Ignition
b - Positive (+) 12 Volt Power Supply From Separate Instrumentation Lighting Circuit

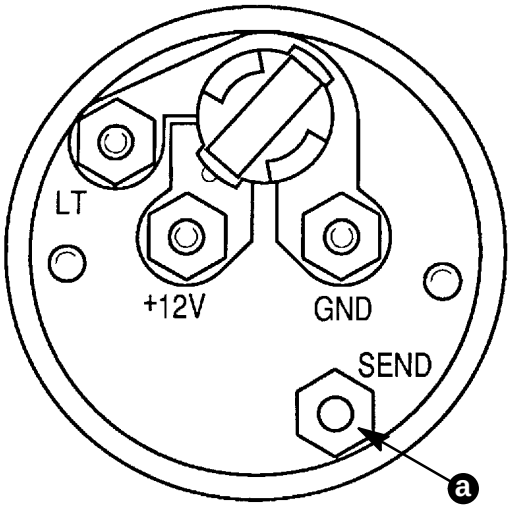
Gauges

Oil, Fuel and Temperature

IMPORTANT: If testing proves gauge to be defective, it must be replaced as there is no repair available.

TESTING

1. Turn ignition switch to OFF.
2. Remove wire from terminal S (SEND).

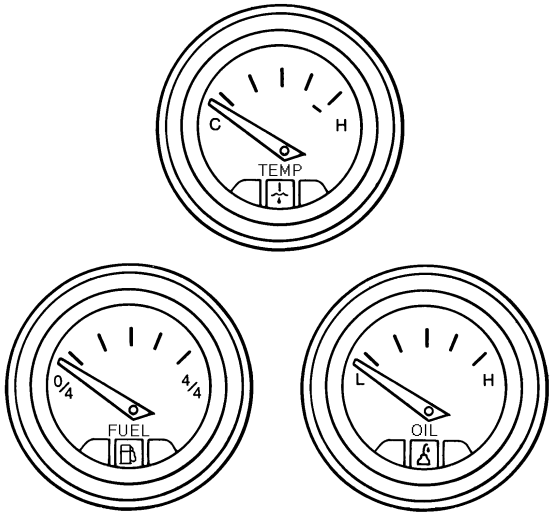


72965

Typical

a - Terminal S (SEND)

3. Turn ignition switch to RUN. Gauge being tested must be at position A.



Position A

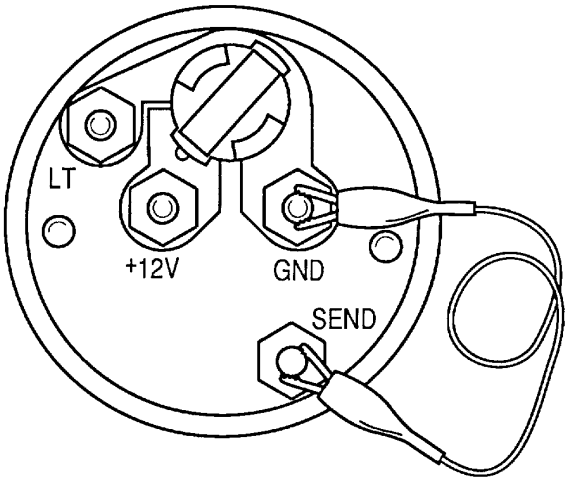
72747

Typical

4. Turn ignition switch to OFF.

Index

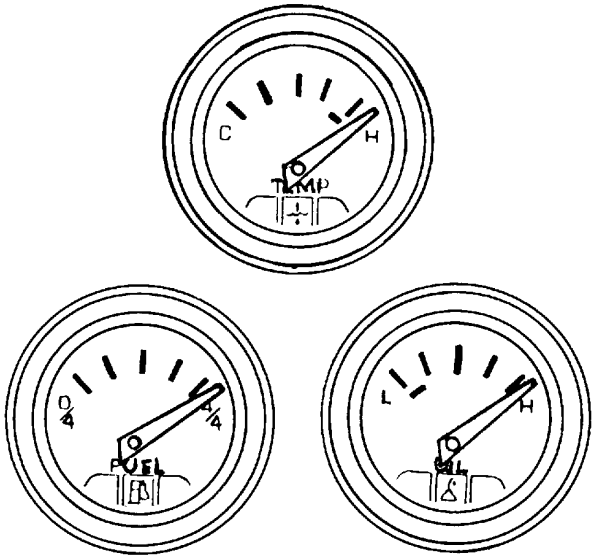
5. Connect jumper wire from terminal G (GND) to terminal S (SEND).



72748

Typical

6. Turn ignition switch to RUN.
7. Indicator needle of gauge being tested must read at position B. If not, replace gauge.



Position B

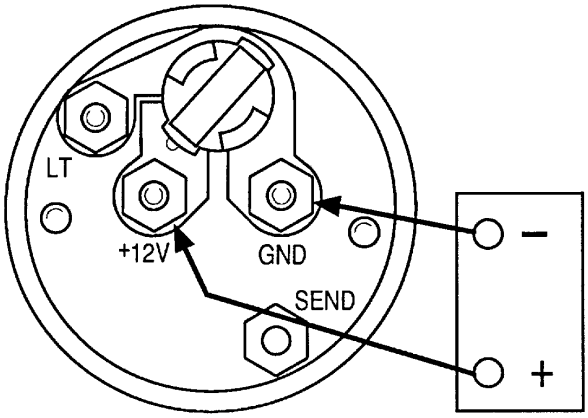
72749

Typical

Battery Gauge

TESTING

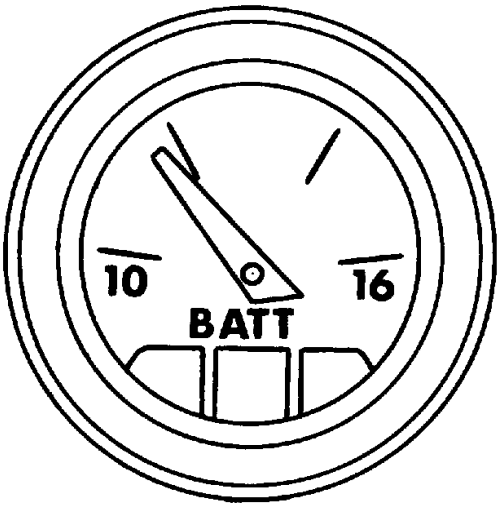
1. Remove cables from battery and fully charge battery.
2. Connect negative (–) jumper lead from battery to gauge terminal G (GND).
3. Connect positive (+) jumper lead from battery to gauge terminal I or +12 V.



72750

Typical

4. Check gauge reading; if not as shown replace gauge.



72751

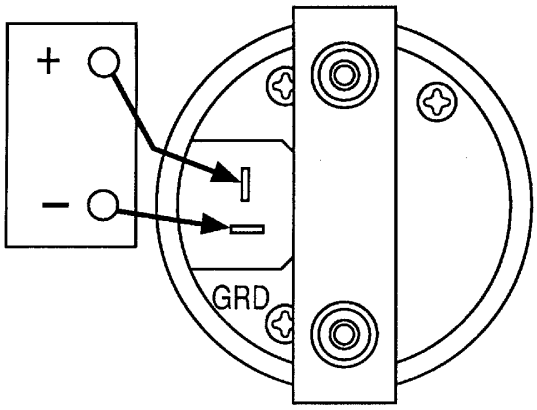
Typical

Index

Cruiselog Meter

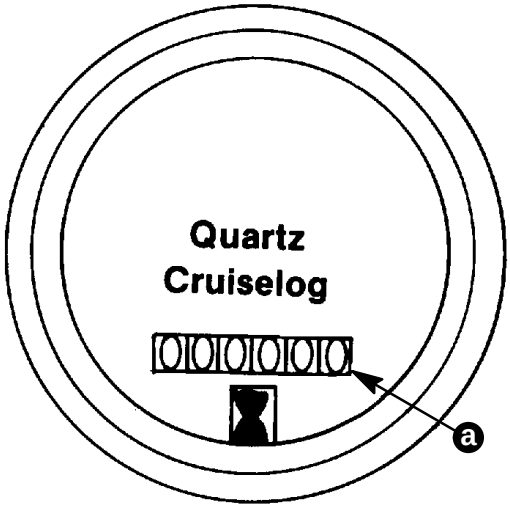
TESTING

1. Connect jumper wire from negative (–) battery terminal to negative (–) gauge terminal.
2. Connect jumper wire from positive (+) battery terminal to positive (+) gauge terminal.



72752

3. Observe gauge run indicator. If indicator is turning, gauge is operable; if not, replace gauge.



72753

a - Indicator

Vacuum Gauge

TESTING

1. Disconnect vacuum hose from engine. Connect service vacuum gauge to engine and record engine vacuum readings at idle, 1000, 2000 and 3000 RPM. Reconnect vacuum hose and compare vacuum gauge readings (at specified RPM) with service gauge readings. Readings should be within 3 inches of vacuum of each other.

IMPORTANT: Make sure that vacuum hose between gauge and engine is not leaking and that all connections are tight.

Speedometer

TESTING

IMPORTANT: When testing speedometer gauge for accuracy, the air supply used for the test must be regulated to the specified air pressure. Do not apply excessive air pressure to speedometer gauge.

1. Apply air pressure directly to speedometer gauge (specified in chart) and note gauge reading. Light tapping of pressure gauge is required during accuracy check.
2. If gauge readings are not within specifications, gauge is defective

CALIBRATION CHART

Air Pressure Gauge PSI	Speedometer Gauge MPH (km/Hr)
5.3	20±2 (32±1.6)
27.8	45±1 (72±1.6)

Tachometer

TESTING

1. Connect a service tachometer to engine and compare readings.
2. Replace if not within specifications.

Tachometer	Allowance
5000 RPM	± 150 RPM

Index

Gauge Replacement

1. Disconnect battery cables from battery.
2. Remove wires from back of gauge.
3. Remove hoses (vacuum, speedometer gauge).
4. Disconnect light socket.
5. Remove holding strap and remove gauge.
6. Position gauge assembly in appropriate mounting hole.
7. Install holding strap and nuts. Tighten nuts evenly and securely.

IMPORTANT: Do not distort case or bracket by over-tightening.

8. Connect ground (BLACK) wire to ground terminal, if gauge is not mounted in metal panel.
9. Connect other wires to gauge as shown in Section 4F.
10. Connect hoses (vacuum, speedometer gauges).
11. Install gauge light socket.
12. Coat all terminals with Quicksilver Liquid Neoprene.
13. Reconnect battery cables to battery.

Senders

Oil Pressure

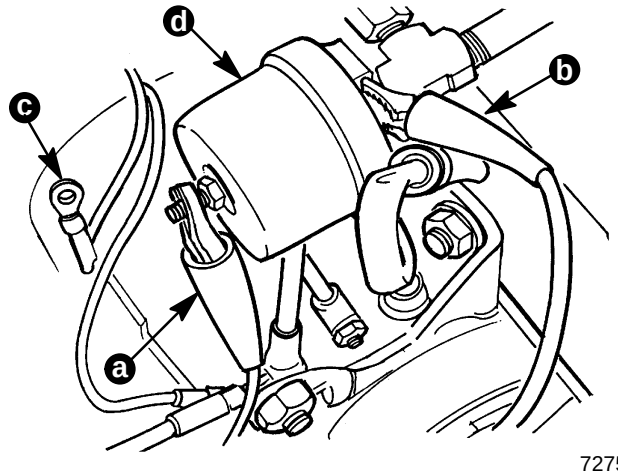
DUAL STATION SENDER IDENTIFICATION

Sender will have 353-AM stamped on hex of sender.

TESTING

IMPORTANT: Use following test procedure for checking accuracy of oil pressure sender only. If oil pressure gauge indicates zero oil pressure, refer to Section 1C - "Troubleshooting."

1. Remove wire from sender terminal.
2. Connect ohmmeter between sender terminal and sender case. Check ohms reading without engine running (zero pressure), then check reading with engine running. Compare oil pressure and ohms readings as shown in following chart:



72754

a - Positive Lead
b - Negative Lead
c - Wire Removed
d - Oil Pressure Sender

Oil Pressure (PSI)	Ohms Reading Single	Dual
0	227-257	113.5-128.5
20	142-162.5	71-81.25
40	91.7-113.6	45.8-56.8
80	9-49	4.5-24.5

Index

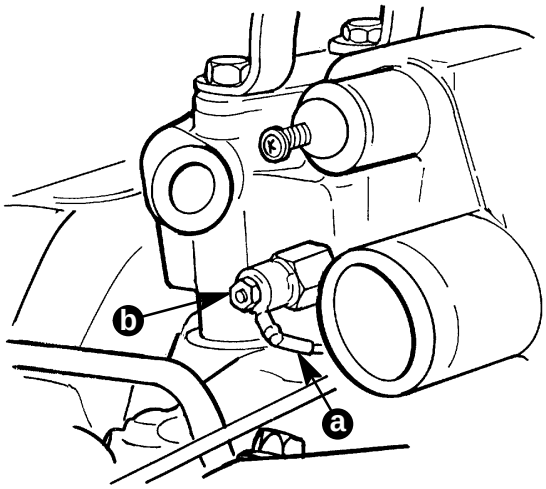
Water Temperature

DUAL STATION SENDER IDENTIFICATION

Sender will have 362-BC stamped on hex.

REMOVAL

1. Drain coolant from closed cooling system into a suitable container as outlined in Section 6B.
2. Remove TAN wire from temperature sender.



72611

Typical Water Temperature Sender

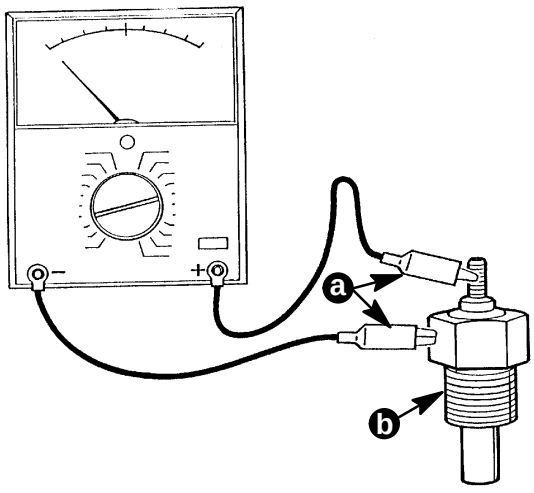
a - TAN Wire
b - Water Temperature Sender

NOTE: *Hoses are shown removed for clarity.*

3. Remove temperature sender.

TESTING

1. Connect an ohmmeter between temperature sender terminal (+) and hex (case) for ground (–) as shown.



72768

a - Ohmmeter Leads
b - Water Temperature Sender

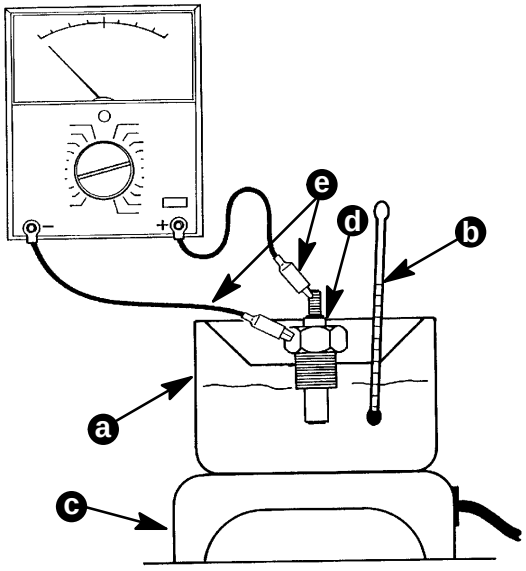
⚠ WARNING

The following test involves the use of intense heat. Failure to follow appropriate procedures or warnings can cause burns which can result in severe personal injury. While performing the following test, observe these general precautions:

- **Wear personal protective clothing such as rubber gloves, a non-flammable apron, and eye protection - preferably full face shield or safety glasses.**
- **The appropriate heat source should only be electric. Heat source should be operated by a qualified person. Be sure to follow all instructions of the manufacturer of the heat source. The heat source should be checked each time it is used to be sure it is functioning properly.**
- **The thermometer used in the test should be a high- temperature thermometer with a maximum reading of at least 300°F (150°C). Under no circumstances should the operator allow temperatures to exceed test specifications.**
- **Perform test only in a well ventilated area.**
- **Use a suitable container, such as metal, to hold the water. Avoid use of glass containers unless the operator first confirms for himself/herself that the glass container is an appropriate high-temperature vessel.**
- **Because the components will reach high temperatures DO NOT handle materials or components until COMPLETELY cooled.**

2. Follow these instructions:
   a. With ohmmeter connected as outlined and using suitable container, thermometer and heat source, suspend sender with tip in water.
   b. Heat water and observe thermometer.
   c. As temperature rises ohmmeter readings must be within the ranges specified for each temperature (see chart below).
   d. Turn heat source off. Allow water and components to cool.

NOTE: *While water cools you may recheck ohmmeter readings.*



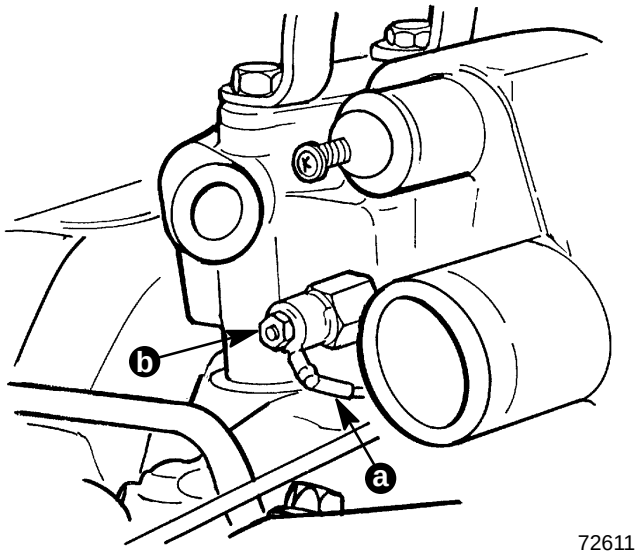
a - Suitable Container
b - Thermometer
c - Heat Source
d - Water Temperature
e - Ohmmeter Leads

Water Temperature	Ohms Reading
140° F (60° C)	121-147
194° F (90° C)	47-55
212° F (100° C)	36-41

3. Replace sender if ohmmeter readings are other than as shown for each temperature.

INSTALLATION

1. Apply Loctite Pipe Sealant with Teflon to threads of temperature sender.
2. Install sender in thermostat housing and tighten securely.
3. Connect tan wire and coat with liquid neoprene.



Typical Water Temperature Sender

a - TAN Wire
b - Water Temperature Sender

4. Refill closed cooling system with approved coolant as outlined in Section 6B.

Fuel Tank Sender

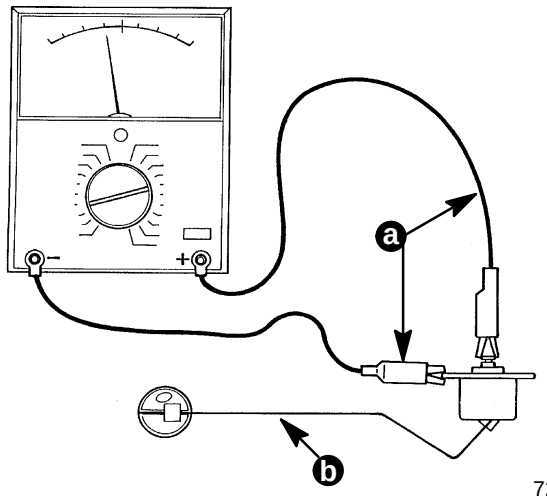
FLANGE TYPE

Testing

1. Disconnect wire from terminal on sending unit and ground wire from sending unit mounting screw.
2. Remove sending unit from fuel tank.
3. Connect ohmmeter between sending unit terminal and sending unit housing.

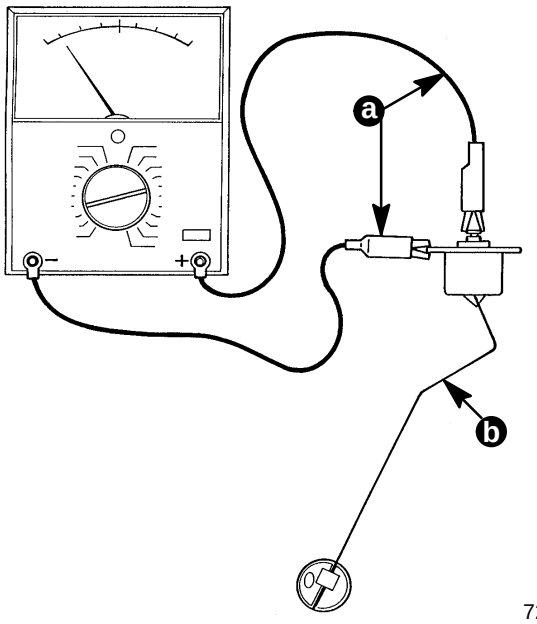
Index

4. With float arm in FULL position (arm horizontal), ohmmeter should read 30 ohms (± 5 ohms).



a - Ohmmeter Leads
b - Vertical Float Arm

5. With float arm in EMPTY position (arm vertical) meter should read 240 ohms (± 5 ohms). Sender is defective if not within specifications.

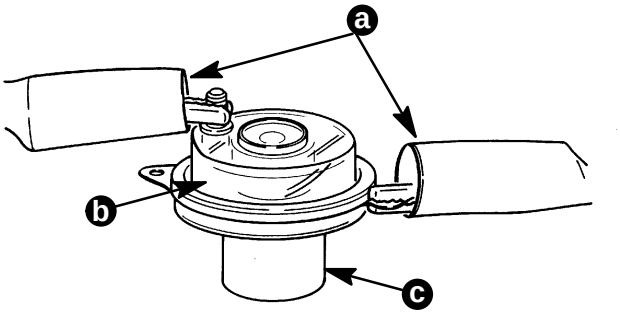


a - Ohmmeter Leads
b - Vertical Float Arm

CAPSULE TYPE

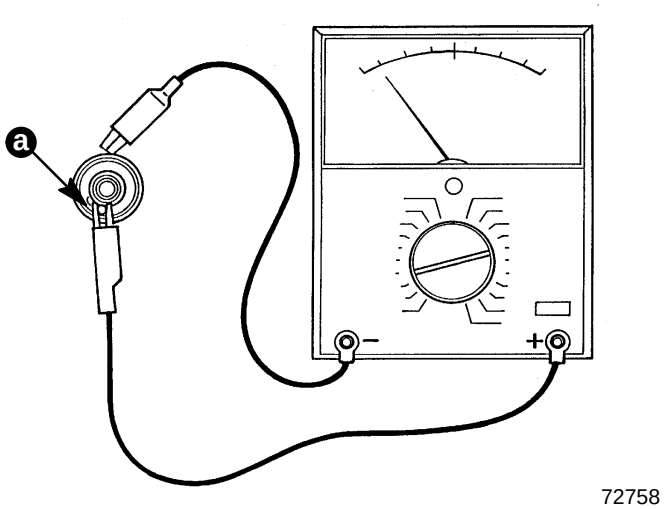
Testing

1. Disconnect wire from terminal on fuel tank capsule.
2. Remove two screws and remove capsule assembly.
3. Place a magnet under fuel capsule.
4. Connect ohmmeter between fuel capsule terminal and metal portion of capsule housing.



a - Ohmmeter Leads
b - Capsule Assembly
c - Magnet

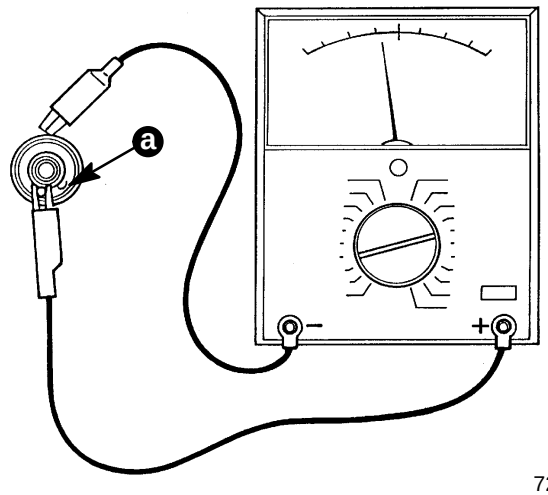
5. Turn magnet counterclockwise until fuel capsule indicator reads EMPTY. Ohmmeter should read 240 ohms (± 5 ohms).



a - Capsule Reading Empty

Index

6. Turn magnet clockwise until fuel capsule indicator reads FULL. Ohmmeter should read 30 ohms (± 5 ohms). Fuel capsule is defective if not within specifications.



72759

a - Capsule Reading Full

Switches

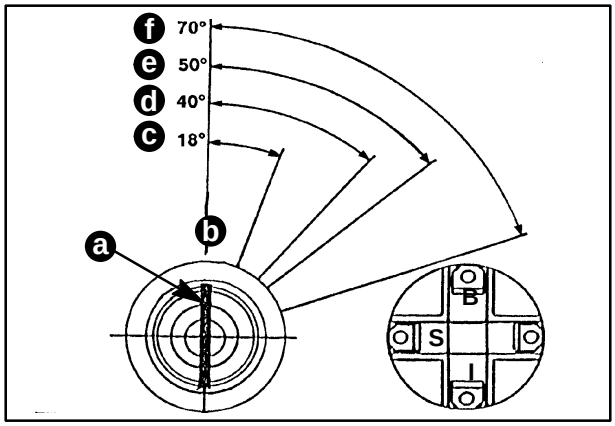
Ignition Key Switch

TESTING

⚠CAUTION

Disconnect battery cables from battery before testing ignition key switch with wires still connected to switch.

1. Disconnect battery cables, if testing ignition key switch with wires connected to switch.
2. Before testing key switch, check all fuses and/or circuit breakers in electrical circuit which could prevent operation of starter.
3. With key switch in OFF position, there should be no continuity between switch terminals.
4. With key switch in RUN position, continuity will exist between switch terminals B to I. There should no continuity between terminal S and any other terminals.
5. With key switch in START, continuity will exist between terminals B to I and B to S.
6. Terminals are to make contact at angles shown and to stay in contact condition as switch is rotated toward START.
7. If ignition key switch tests bad, unsolder wire connections and remove switch. Test switch again, as in Steps 2-5, preceding. If switch tests good, wiring in harness is bad, There should be no continuity between any harness wires with key switch removed.

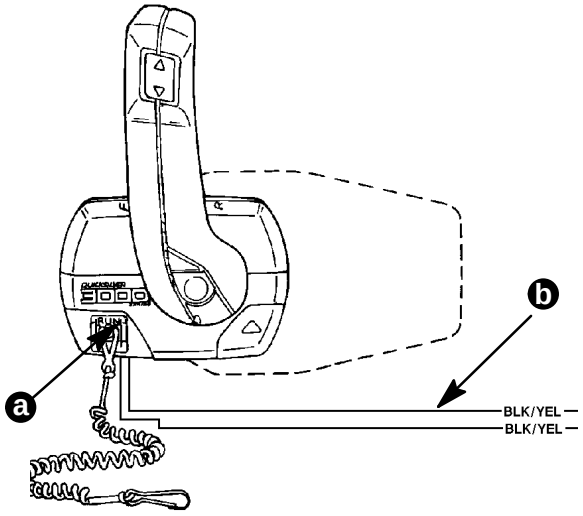


72760

a - Key
b - Off
c - Continuity, B to I Terminals
d - Run
e - Continuity B to S Terminals
f - Start

Lanyard Stop Switches

TESTING

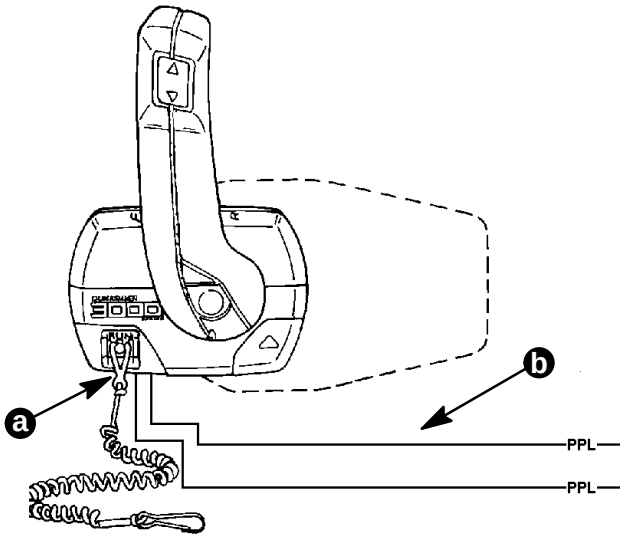


74061

Remote Control Mounted Style Switch Electronic Fuel Injection (EFI) Engines

a - Switch Lanyard
b - Leads (BLK/YEL)

1. Disconnect switch leads.
2. Test switch as follows.
   a. Connect an ohmmeter to leads.
   b. There should be no continuity with switch lanyard connected and continuity with switch lanyard disconnected.

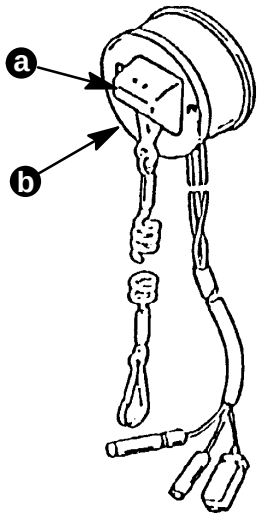


74062

Remote Control Mounted Style Switch Carbureted Engines

a - Switch Leads
b - Leads (PUR)

1. Disconnect switch leads.
2. Test switch as follows.
   a. Connect an ohmmeter to leads.
   b. There should be continuity with switch lanyard connected and no continuity with switch lanyard disconnected.



72762

Toggle Style Switch

a - Switch Cap
b - Switch

Index

IMPORTANT: The BLK/YEL lead is not used. It should be well insulated and taped to harness.

1. Disconnect switch leads.
2. Connect an ohmmeter to switch leads.
3. Switch should have continuity with toggle in the RUN position and no continuity with toggle in the OFF position.

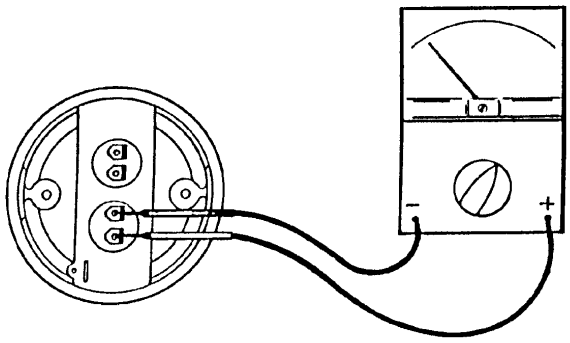
Start/Stop Switch

TESTING

⚠ WARNING

Disconnect battery leads at battery before testing.

1. Disconnect battery leads.
2. Check for continuity between the terminals on the start switch with a continuity meter.



72763

3. No continuity should exist.
4. Depress switch button and continuity should exist.
5. Check stop switch in the same manner.
6. If continuity exists when in the OPEN (not depressed) state, replace panel button.

Audio Warning System

NOTICE

For repair procedures on Fuel Injection Engines, refer to Section 5C.

Buzzer

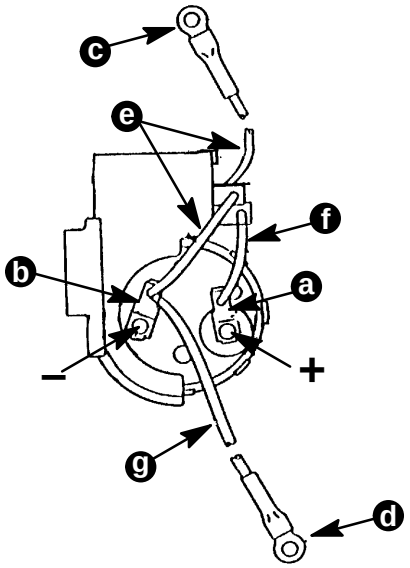
⚠ WARNING

The following test involves the use of electricity. Failure to follow appropriate procedures can cause burns or shock which can result in severe personal injury or death.

TESTING

1. Turn key to RUN position (engine off).
2. Wait 7 to 14 seconds for horn to sound.
3. If horn does not sound:
   a. Connect jumper wires as shown.
   b. If horn does not sound, replace it.
4. If horn worked in Step 3:
   a. Connect jumper wires as shown.
   b. Repeat Step 2.

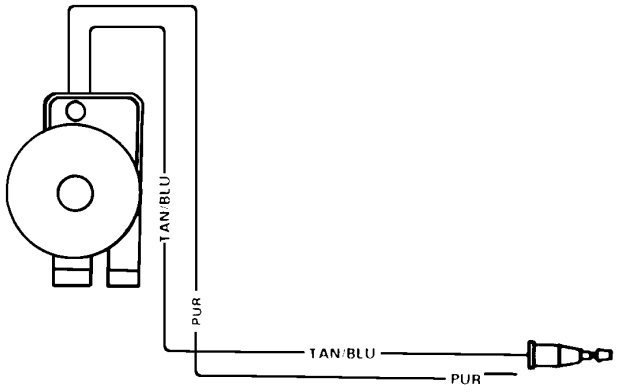
c. If horn sounds, problem is in tan/blue wire back to engine or switches on engine.



72612

Buzzer For 1994 Model And Older Carbureted Engines

a - Jumper Wire To 12 Volt (+) Step 3
b - Jumper Wire To Negative (–) Step 3
c - Jumper Wire To 12 Volt (+) Step 4
d - Jumper Wire To Negative (–) Step 4
e - PURPLE Wire
f - RED Wire
g - TAN/BLUE Wire



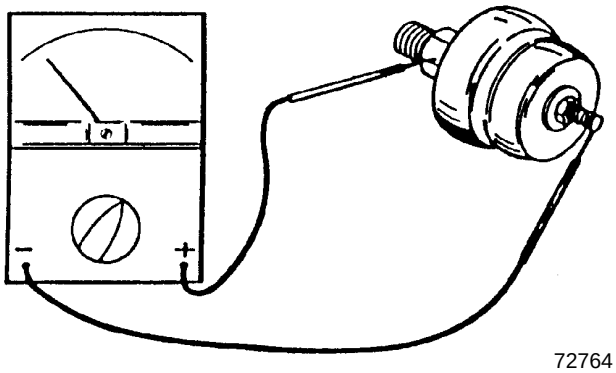
74046

Buzzer For EFI and 1995 Model And Newer Carbureted Engines (No Timer Circuit)

Oil Pressure Switch

TESTING

1. Remove wire from sender terminal.
2. Connect continuity meter between sender terminal and sender hex. (Sender shown removed for clarity.)



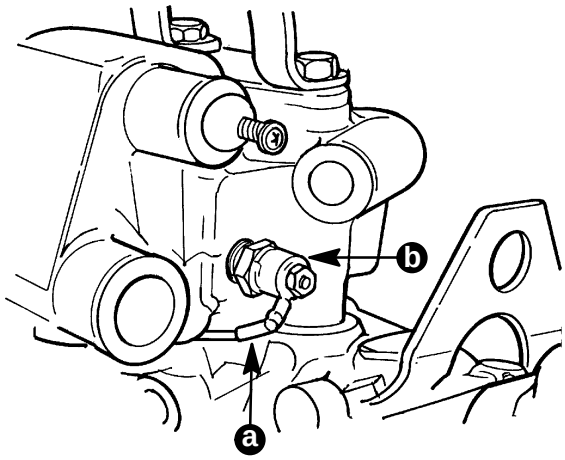
72764

3. With engine not running, meter should indicate full continuity.
4. Start engine. With engine running and engine oil pressure above 6 PSI (41 kPa), meter should indicate NO continuity.

Water Temperature Switch

REMOVAL

1. Drain coolant from closed cooling system into a suitable container as outlined in Section 6B.
2. Remove tan/blue wire from temperature switch.



72613

a - TAN/BLUE Wire
b - Water Temperature Switch

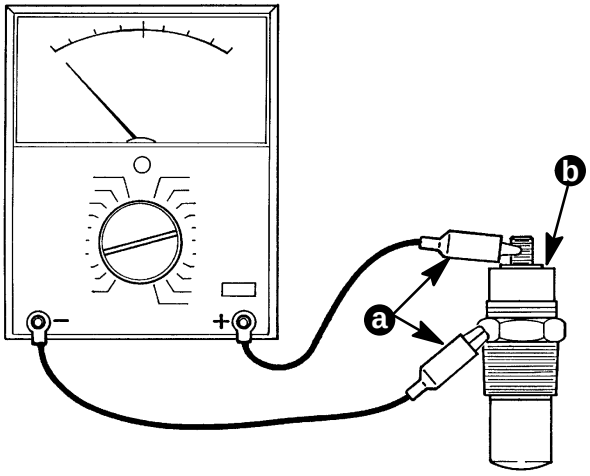
Index

NOTE: *Coolant hoses shown removed for clarity.*

3. Remove switch.

TESTING

1. Connect an ohmmeter between water temperature switch terminal (+) and hex (case) for ground (–) as shown.



72765

a - Ohmmeter Leads
b - Water Temperature Switch

2. Switch should read no continuity.

⚠ WARNING

The following test involves the use of intense heat. Failure to follow appropriate procedures or warnings can cause burns which can result in severe personal injury. While performing the following test, observe these general precautions:

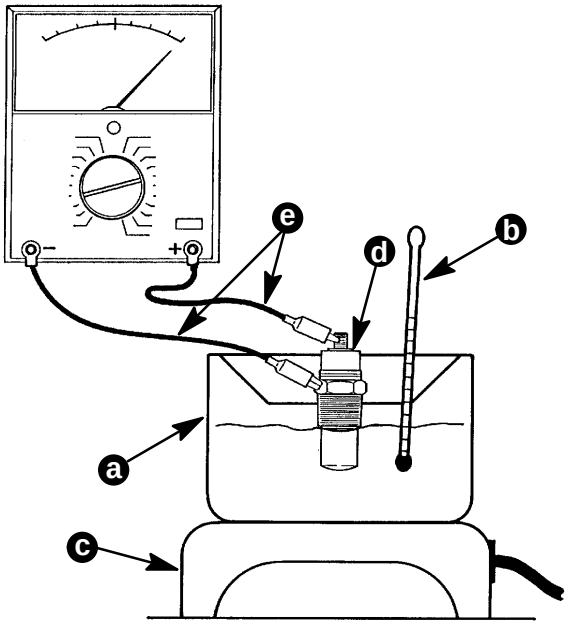
- **Wear personal protective clothing such as rubber gloves, a non-flammable apron, and eye protection - preferably full face shield or safety glasses.**
- **The appropriate heat source should only be electric. Heat source should be operated by a qualified person. Be sure to follow all instructions of the manufacturer of the heat source. The heat source should be checked each time it is used to be sure it is functioning properly.**
- **The thermometer used in the test should be a high- temperature thermometer with a maximum reading of at least 300°F (150°C). Under no circumstances should the operator allow temperatures to exceed test specifications.**
- **Perform test only in a well ventilated area.**
- **Use a suitable container, such as metal, to hold the sand. Avoid use of glass containers unless the operator first confirms for himself/herself that the glass container is an appropriate high-temperature vessel.**
- **Because the components will reach high temperatures DO NOT handle materials or components until COMPLETELY cooled.**

Index

⚠ WARNING

Use only clean, dry sand such as used for general sandblasting purposes. Use of sand containing contaminants could result in hazards such as fire, short circuiting, hot-spots, or other hazards.

3. Follow these instructions:
   a. With an ohmmeter connected as outlined and using suitable container, thermometer and heat source, suspend sender with tip in sand.
   b. Heat sand and observe temperature on thermometer.



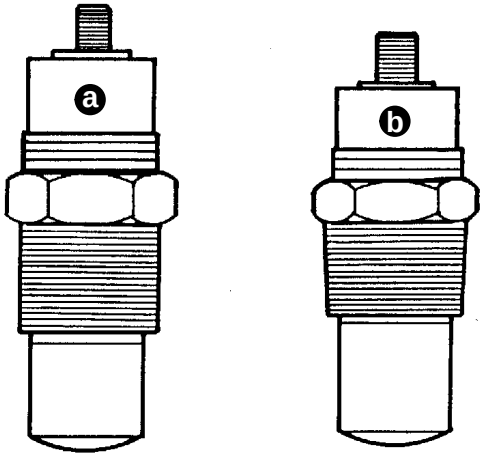
72766

a - Suitable Container
b - Thermometer
c - Heat Source
d - Water Temperature Switch
e - Ohmmeter Leads

   c. As temperature rises, switch will close and ohmmeter will indicate continuity. Refer to chart below for specifications.

48952 Switch	
Opens	150-170° F (60-77° C)
Closes	190-200° F (88-93° C)

87-86080 Switch	
Opens	175-195° F (60-77° C)
Closes	215-225° F (88-93° C)



72767

Switch Identification

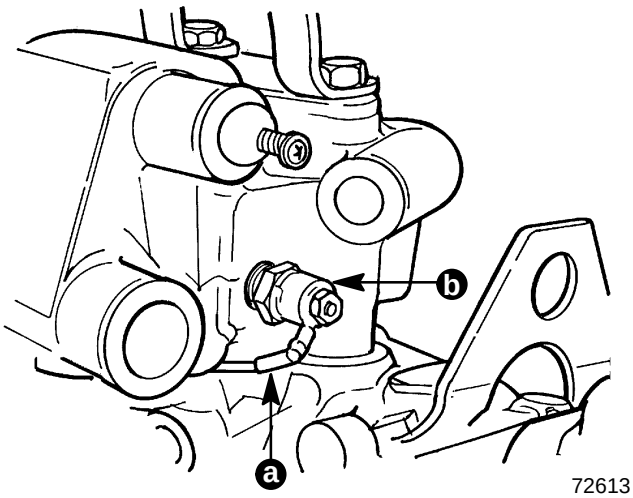
a - 48952 Switch With Red Mylar Sleeve
b - 87-86080 Switch With Black Mylar Sleeve

4. Turn heat source off. Allow sand to cool. Note thermometer reading to ensure switch “opens” up at specified temperature.
5. Replace switch if switch fails to either open or close within the specified temperatures.

Index

INSTALLATION

1. Apply Loctite Pipe Sealant with Teflon to threads of water temperature switch.
2. Install switch in thermostat housing and tighten securely.
3. Connect tan/blue wire and coat connection with liquid neoprene.



72613

a - TAN / BLUE Wire
b - Water Temperature Switch

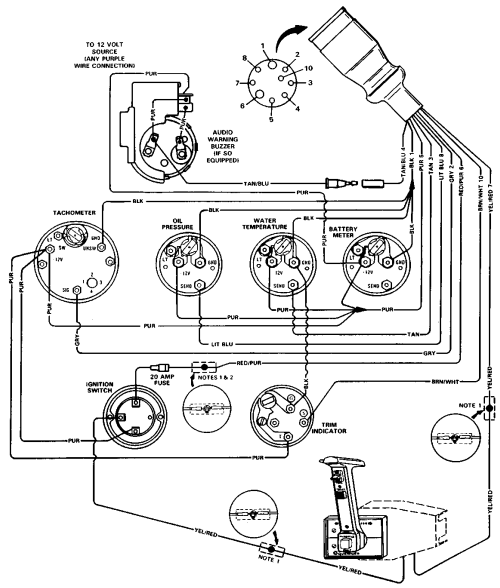
4. Refill closed cooling system with approved coolant as outlined in Section 6B.

Index

ELECTRICAL SYSTEMS

4

E



72938

WIRING DIAGRAMS

Index

Table of Contents

	Page
Wiring Colors for MerCruiser	4E-1
MCM V-6 Alpha Thunderbolt IV	4E-2
MCM V-6 Gen + Alpha Thunderbolt V Without Knock Sensor	4E-3
MCM V-6 Gen + Bravo Thunderbolt V Without Knock Sensor	4E-4
MCM 262 Magnum EFI Gen + Alpha and Bravo Starting and Charging Harness	4E-5
MCM 262 Magnum EFI Gen + Alpha (Vapor Separator Tank [VST]) EFI System Harness	4E-6
MCM 262 Magnum EFI Gen + Bravo (Vapor Separator Tank [VST]) EFI System Harness	4E-7
MCM 262 Magnum EFI Gen + Alpha (Cool Fuel System) EFI System Harness	4E-8
MCM 262 Magnum EFI Gen + Bravo (Cool Fuel System) EFI System Harness	4E-9
Quicksilver Instrumentation	4E-10
Dual Station Wiring (Using a Neutral Safety Switch in Only One Remote Control)	4E-11
Dual Station Wiring (Using A Neutral Safety Switch In Both Remote Controls)	4E-12
Dual Station Wiring (Using a Neutral Safety Switch in Engine Wiring Harness)	4E-13
EFI Wiring Diagram (Chart 1 Of 4)	4E-14
EFI Wiring Diagram (Chart 2 Of 4)	4E-15
EFI Wiring Diagram (Chart 3 Of 4)	4E-16
EFI Wiring Diagram (Chart 4 Of 4)	4E-17

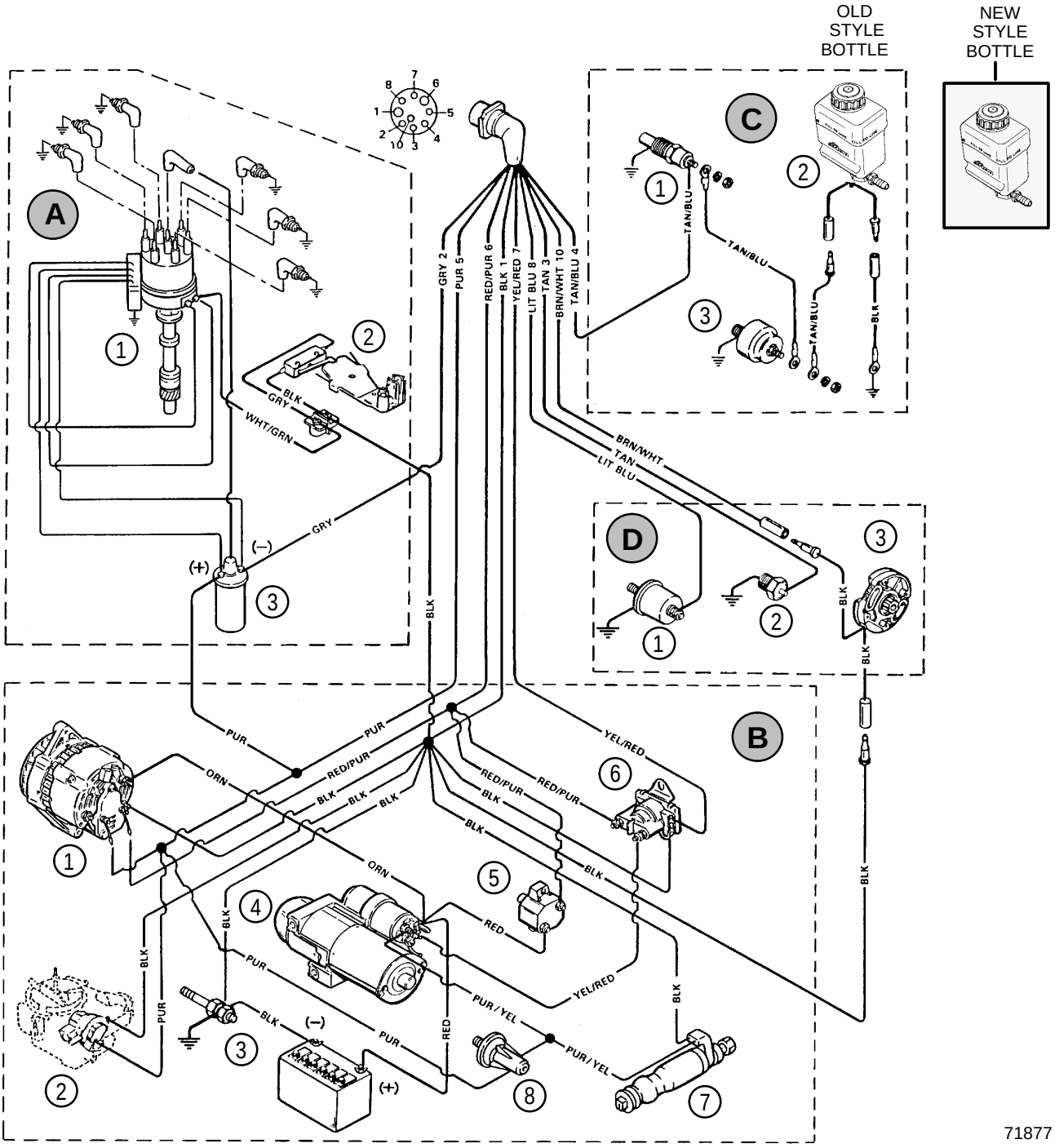
Index

Wiring Colors for MerCruiser

NOTE: *Color codes listed below DO NOT apply to fuel injection system harnesses.*

BIA COLOR CODE AND ABBREVIATIONS	WHERE USED
BLACK (BLK)	All Grounds
BROWN (BLU)	Reference Electrode - MerCathode
ORANGE (ORN)	Anode Electrode-MerCathode
LT. BLUE/WHITE (LT BLU/WHT)	Trim - ”Up” Switch
GRAY (GRY)	Tachometer Signal
GREEN/WHITE (GRN/WHT)	Trim - ”Down” Switch
TAN (TAN)	Water Temperature Sender to Gauge
LIGHT BLUE (LIT BLU)	Oil Pressure Sender to Gauge
PINK (PNK)	Fuel Gauge Sender to Gauge
BROWN/WHITE (BRN/WHT)	Trim Sender to Trim Gauge
PURPLE/WHITE (PUR/WHT)	Trim - ”Trailer” Switch
RED (RED)	Unprotected Wires from Battery
RED/PURPLE (RED/PUR)	Protected (Fused) Wires from Battery
RED/PURPLE (RED/PUR)	Protected (+12V) to Trim Panel
ORANGE (ORN)	Alternator Output
PURPLE/YELLOW (PUR/YEL)	Ballast Bypass
PURPLE (PUR)	Ignition Switch (+12V)
YELLOW/RED (YEL/RED)	Starter Switch to Starter Solenoid to Neutral Start Switch

MCM V-6 Alpha Thunderbolt IV



A - Ignition System
1 - Distributor
2 - Shift Cutout Switch
3 - Ignition Coil

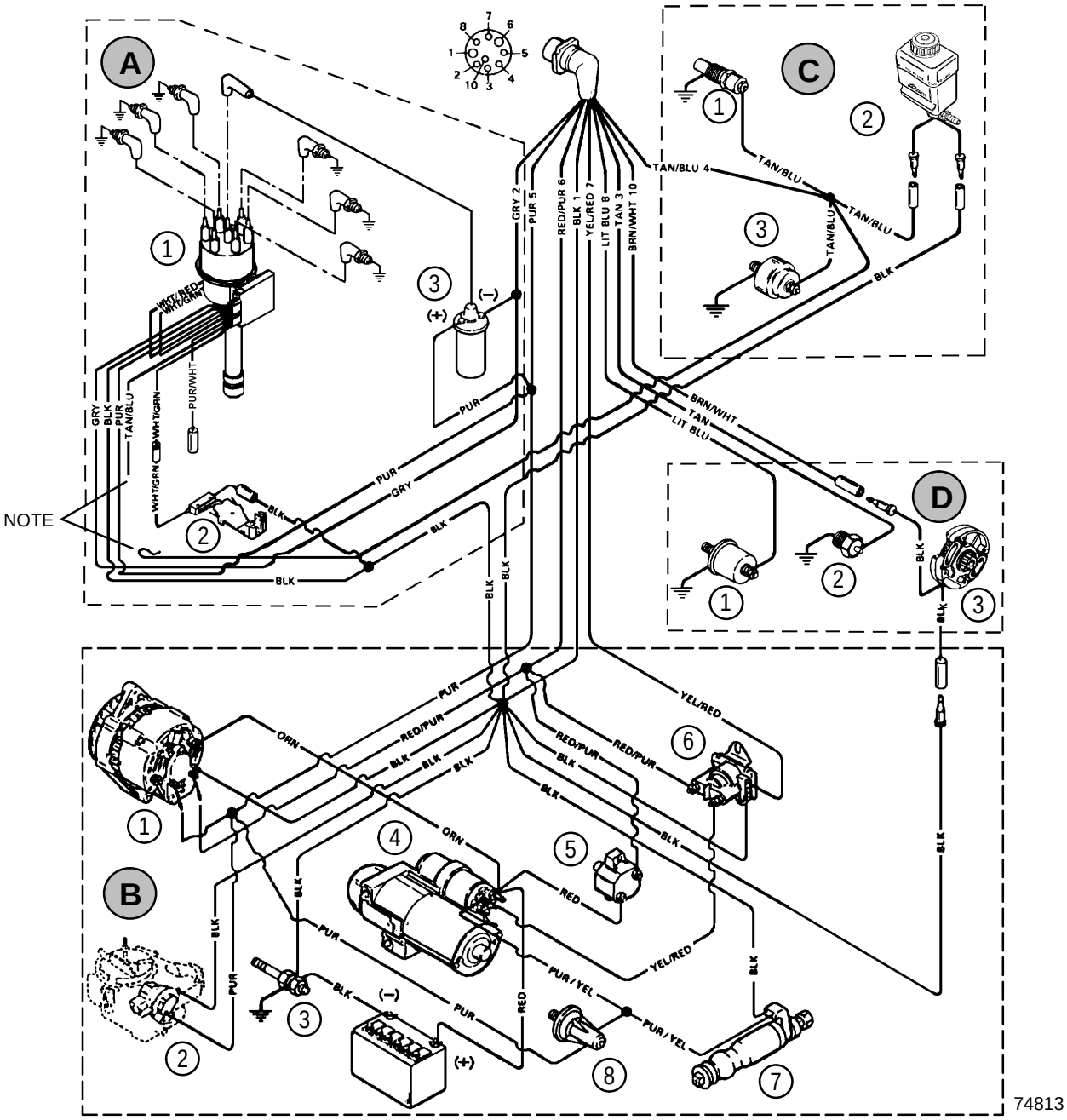
B - Starting System
1 - Alternator
2 - Electric Choke
3 - Ground Bolt
4 - Starter
5 - Circuit Breaker
6 - Starter Slave Solenoid
7 - Electric Fuel Pump
8 - Oil Pressure Cut-Off Switch

C - Audio Warning System
1 - Water Temperature
2 - Drive Unit Oil Level (If Equipped)
3 - Oil Pressure Switch

D - Instrumentation System
1 - Oil Pressure Sender
2 - Water Temperature Sender
3 - Trim Sender

Index

MCM V-6 Gen + Alpha Thunderbolt V Without Knock Sensor



NOTE: *TAN/BLU wire is not used at distributor.*

A - Ignition System
1 - Distributor
2 - Shift Cutout Switch
3 - Ignition Coil

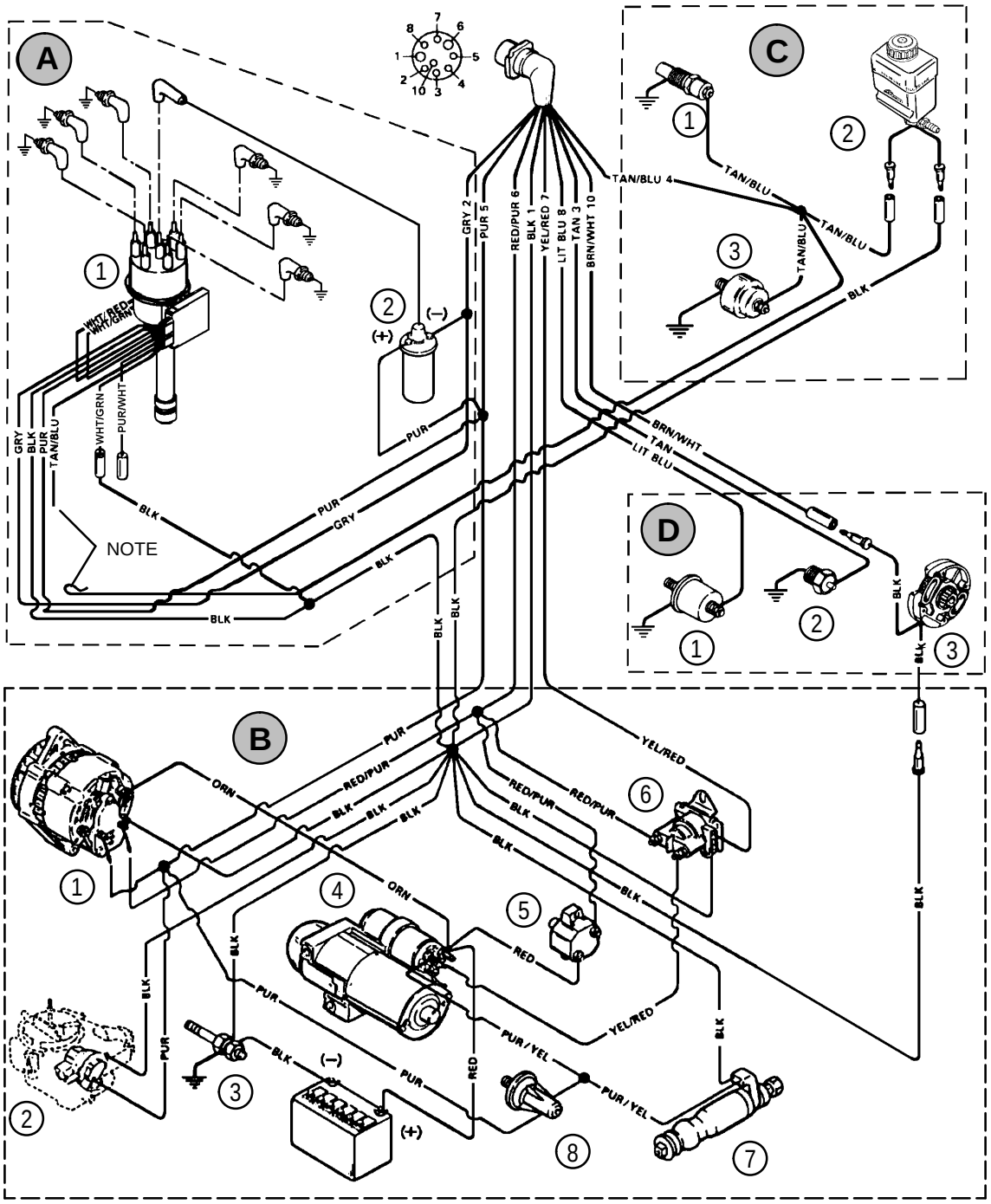
B - Starting System
1 - Alternator
2 - Electric Choke
3 - Ground Bolt
4 - Starter
5 - Circuit Breaker
6 - Starter Slave Solenoid
7 - Electric Fuel Pump
8 - Oil Pressure Cut-Off Switch

C - Audio Warning System
1 - Water Temperature
2 - Drive Unit Oil Level (If Equipped)
3 - Oil Pressure Switch

D - Instrumentation System
1 - Oil Pressure Sender
2 - Water Temperature Sender
3 - Trim Sender

Index

MCM V-6 Gen + Bravo Thunderbolt V Without Knock Sensor



74814

NOTE: *TAN/BLU wire is not used at distributor.*

A - Ignition System
1 - Distributor
2 - Ignition Coil

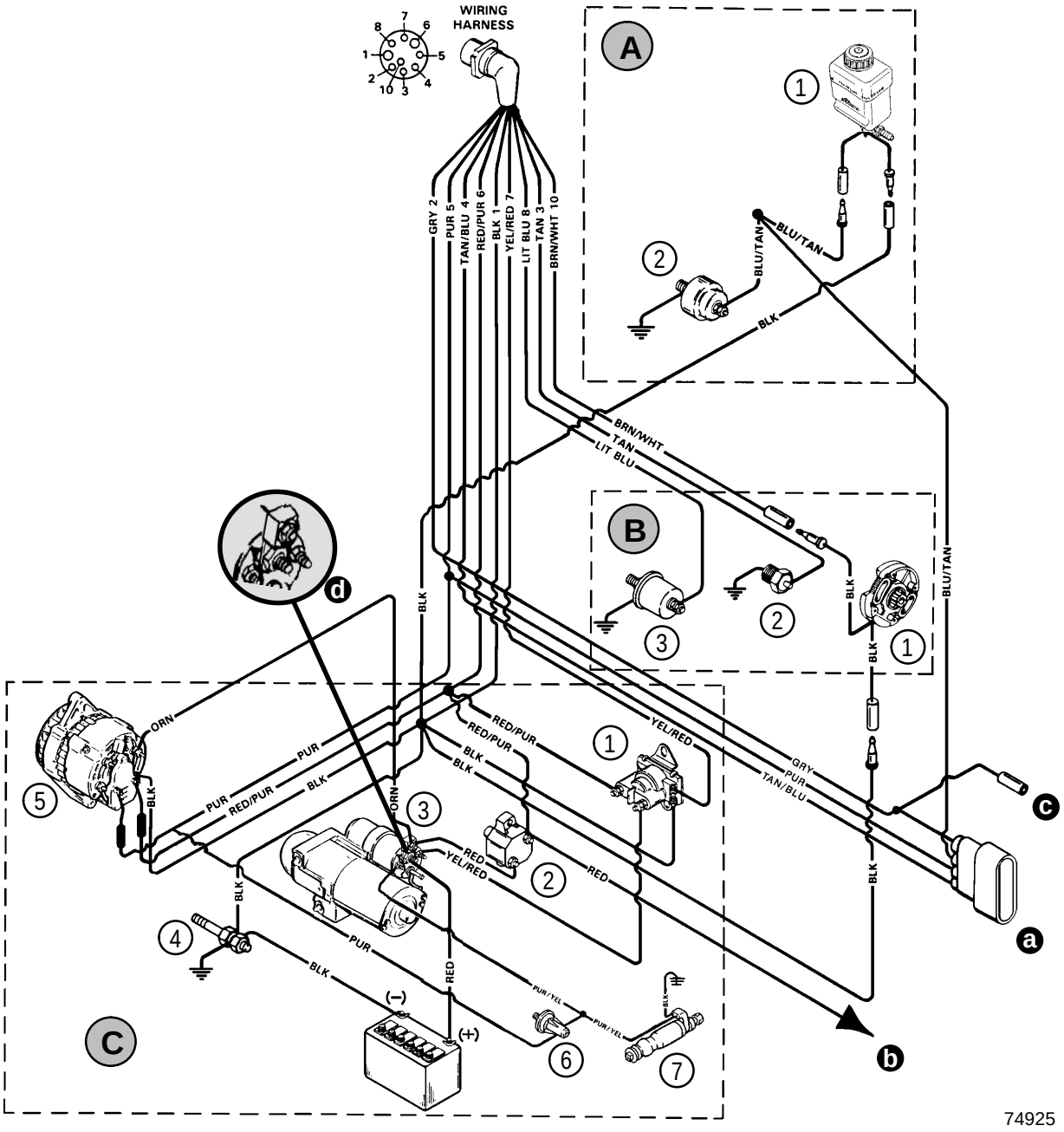
B - Starting System
1 - Alternator
2 - Electric Choke (2 BBL Only)
3 - Ground Bolt
4 - Starter
5 - Circuit Breaker
6 - Starter Slave Solenoid
7 - Fuel Pump
8 - Oil Pressure Cut-Off Switch

C - Audio Warning System
1 - Water Temperature
2 - Drive Unit Oil Level (If Equipped)
3 - Oil Pressure Switch

D - Instrumentation System
1 - Oil Pressure Sender
2 - Water Temperature Sender
3 - Trim Sender

Index

MCM 262 Magnum EFI Gen + Alpha and Bravo Starting and Charging Harness

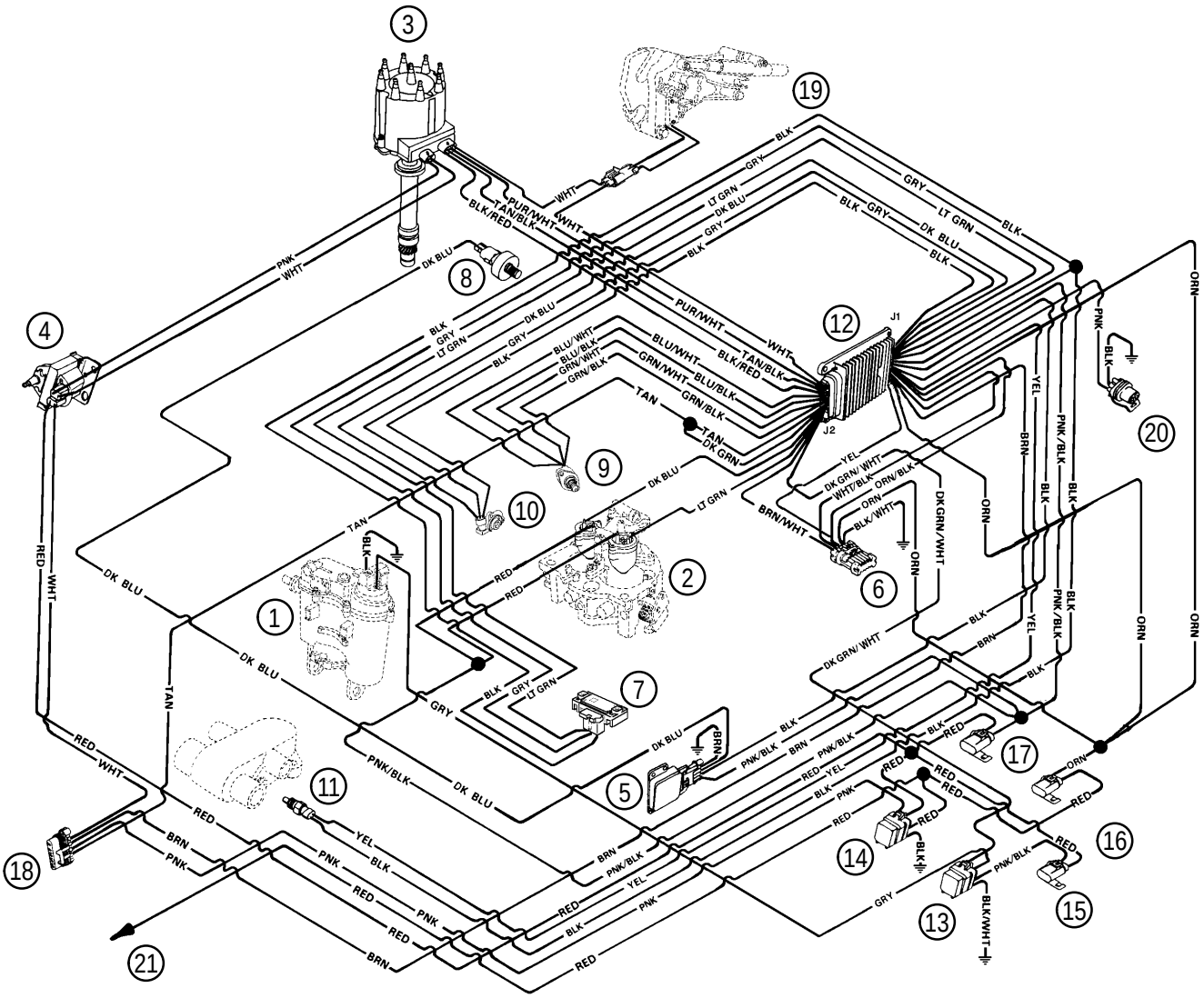


A– Audio Warning System
1 - Drive Unit Oil Level
2 - Oil Pressure Switch
B– Instrumentation System
1 - Trim Sender
2 - Water Temperature Sender
3 - Oil Pressure Sender
C - Charging and Starting System
1 - Starter Slave Solenoid
2 - Circuit Breaker
3 - Starter
4 - Ground Stud
5 - Alternator
6 - O**il** Pressure Cut-Off Switch
7 - Fuel Pump

a - Harness Connector to EFI System Harness
b - Positive (+) Power Wire to EFI System Harness
c - Auxiliary Tachometer Lead
d -90 Amp Fuse (DO NOT Remove)

Index

MCM 262 Magnum EFI Gen + Alpha (Vapor Separator Tank [VST])
EFI System Harness

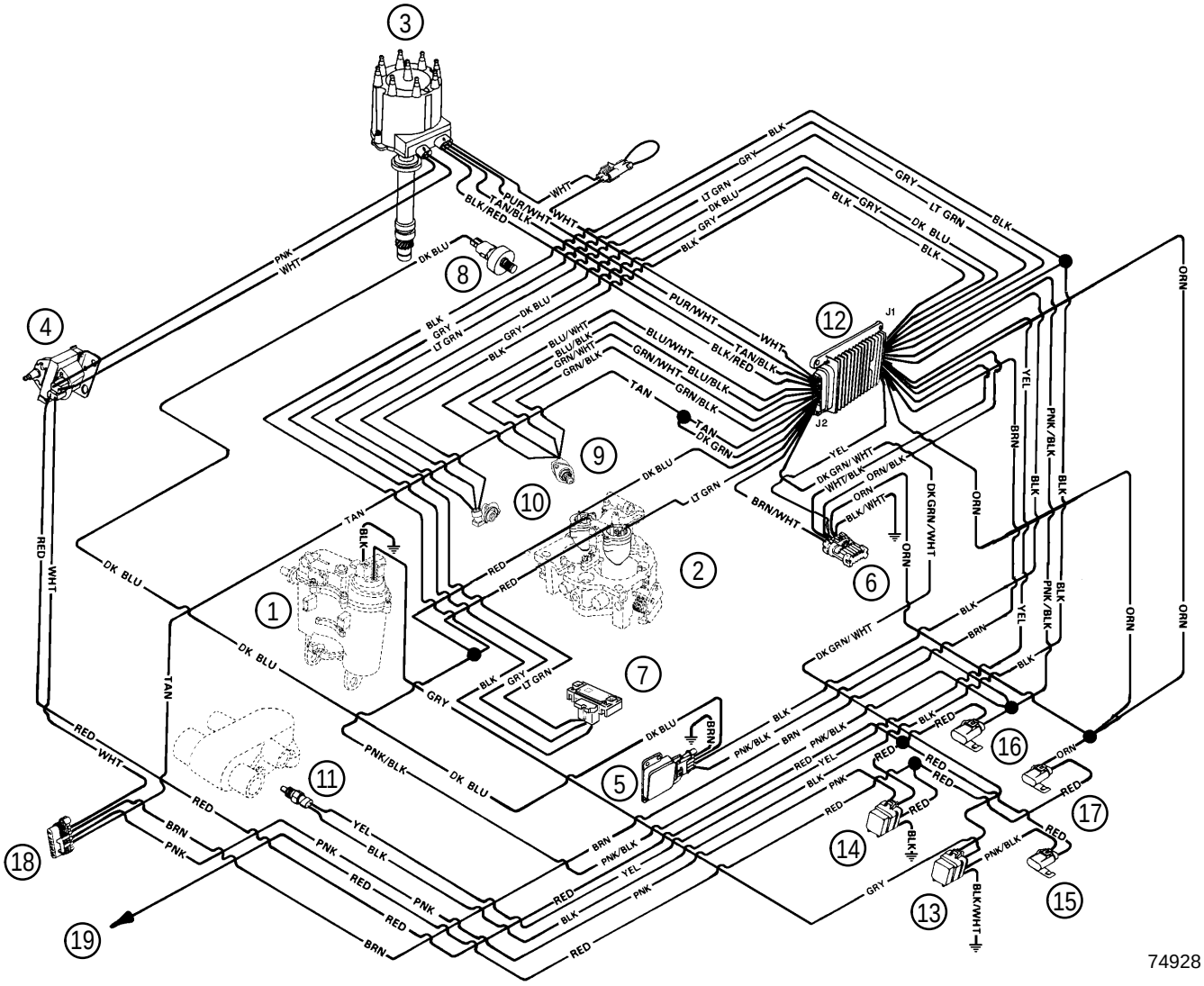


NOTE: All BLACK wires with a ground symbol are interconnected within the EFI system harness.

1 - Vapor Separator Tank (VST)
2 - Throttle Body
3 - Distributor
4 - Coil
5 - Knock Sensor (KS) Module
6 - Data Link Connector (DLC)
7 - Manifold Absolute Pressure (MAP) Sensor
8 - Knock Sensor
9 - Idle Air Control (IAC)
10- Throttle Position (TP) Sensor
11- Engine Coolant Temperature Sensor (ECT)
12- Electronic Control Module (ECM)
13- Fuel Pump Relay
14- Ignition/System Relay
15- Fuel Pump Fuse
16- ECM/Ignition Feed/KS Module/Injectors Fuse
17- ECM/DLC/Battery Fuse
18- Harness Connector To Starting/Charging Harness
19- Shift Cutout Switch
20- Lanyard Stop Switch
21- Positive Power Wire To Engine Circuit Breaker

Index

MCM 262 Magnum EFI Gen + Bravo (Vapor Separator Tank [VST])
EFI System Harness

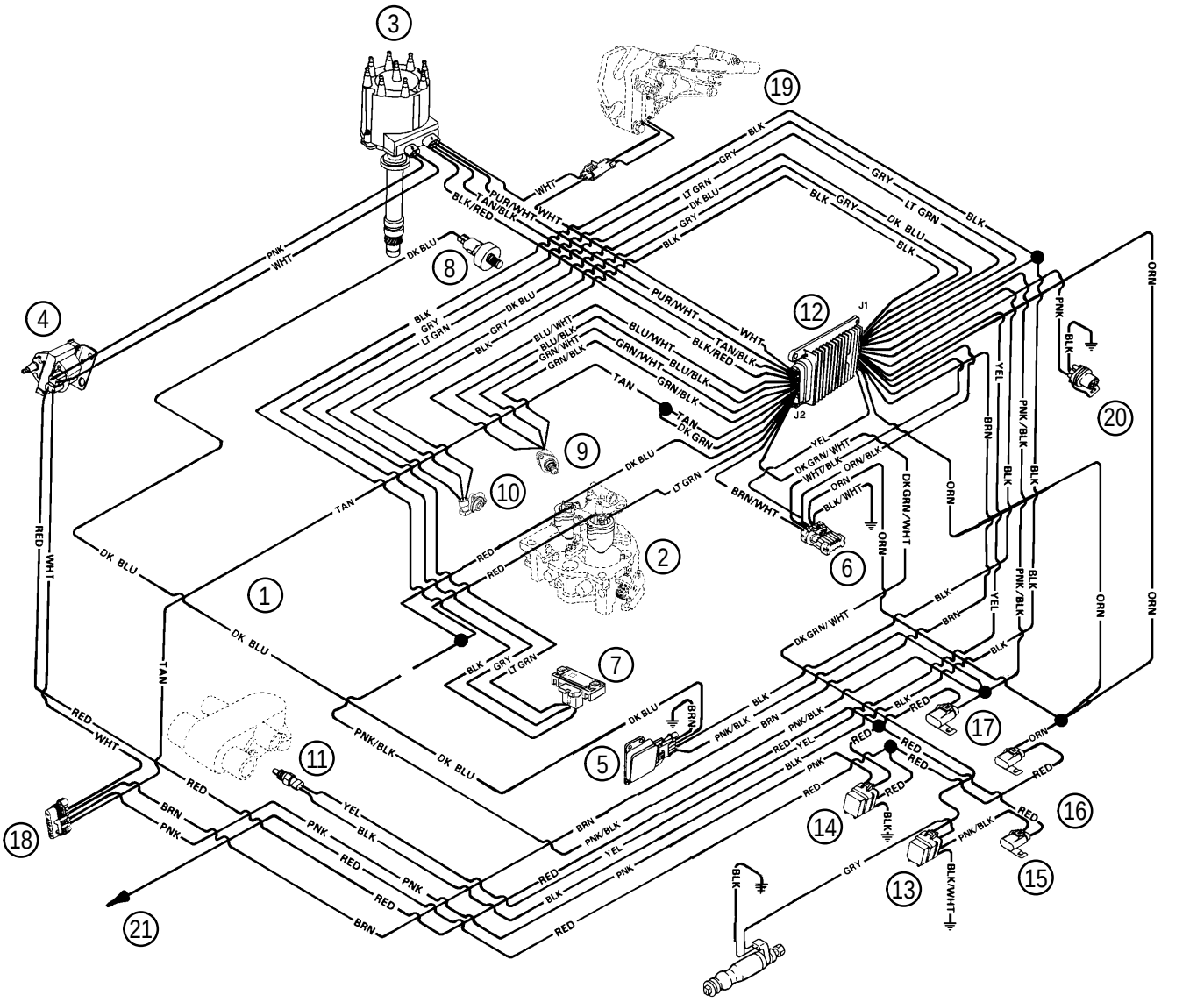


NOTE: All BLACK wires with a ground symbol are interconnected within the EFI system harness.

1 - Vapor Separator Tank (VST)
2 - Throttle Body
3 - Distributor
4 - Coil
5 - Knock Sensor (KS) Module
6 - Data Link Connector (DLC)
7 - Manifold Absolute Pressure (MAP) Sensor
8 - Knock Sensor
9 - Idle Air Control (IAC)
10- Throttle Position (TP) Sensor
11- Engine Coolant Temperature Sensor (ECT)
12- Electronic Control Module (ECM)
13- Fuel Pump Relay
14- Ignition/System Relay
15- Fuel Pump Fuse
16- ECM/Ignition Feed/KS Module/Injectors Fuse
17- ECM/DLC/Battery Fuse
18- Harness Connector To Starting/Charging Harness
19- Positive (+) Power Lead To Engine Circuit Breaker

Index

MCM 262 Magnum EFI Gen + Alpha (Cool Fuel System)
EFI System Harness

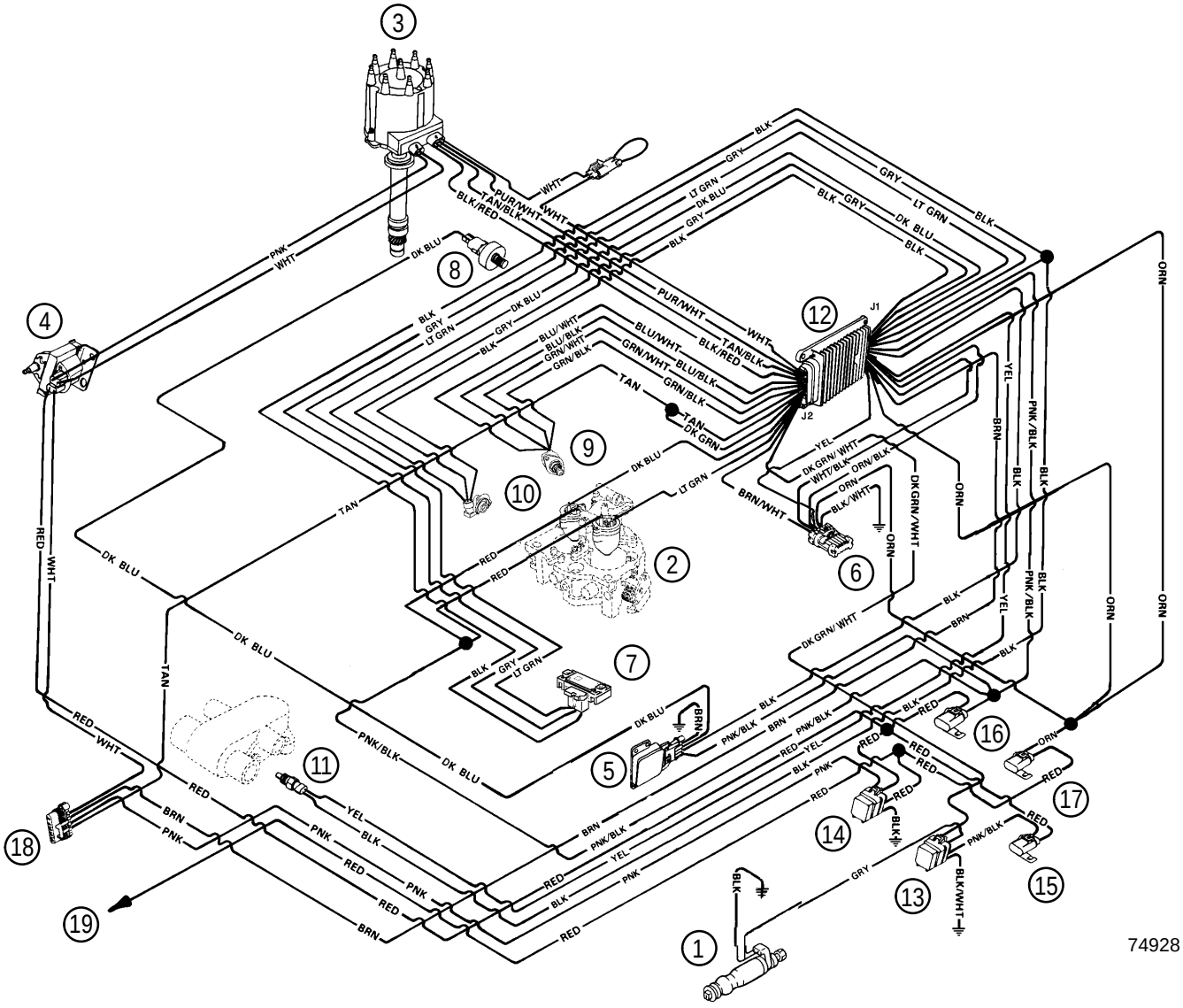


NOTE: All BLACK wires with a ground symbol are interconnected within the EFI system harness.

1 - Vapor Separator Tank (VST)
2 - Throttle Body
3 - Distributor
4 - Coil
5 - Knock Sensor (KS) Module
6 - Data Link Connector (DLC)
7 - Manifold Absolute Pressure (MAP) Sensor
8 - Knock Sensor
9 - Idle Air Control (IAC)
10- Throttle Position (TP) Sensor
11- Engine Coolant Temperature Sensor (ECT)
12- Electronic Control Module (ECM)
13- Fuel Pump Relay
14- Ignition/System Relay
15- Fuel Pump Fuse
16- ECM/Ignition Feed/KS Module/Injectors Fuse
17- ECM/DLC/Battery Fuse
18- Harness Connector To Starting/Charging Harness
19- Shift Cutout Switch
20- Lanyard Stop Switch
21- Positive Power Wire To Engine Circuit Breaker

Index

MCM 262 Magnum EFI Gen + Bravo (Cool Fuel System)
EFI System Harness

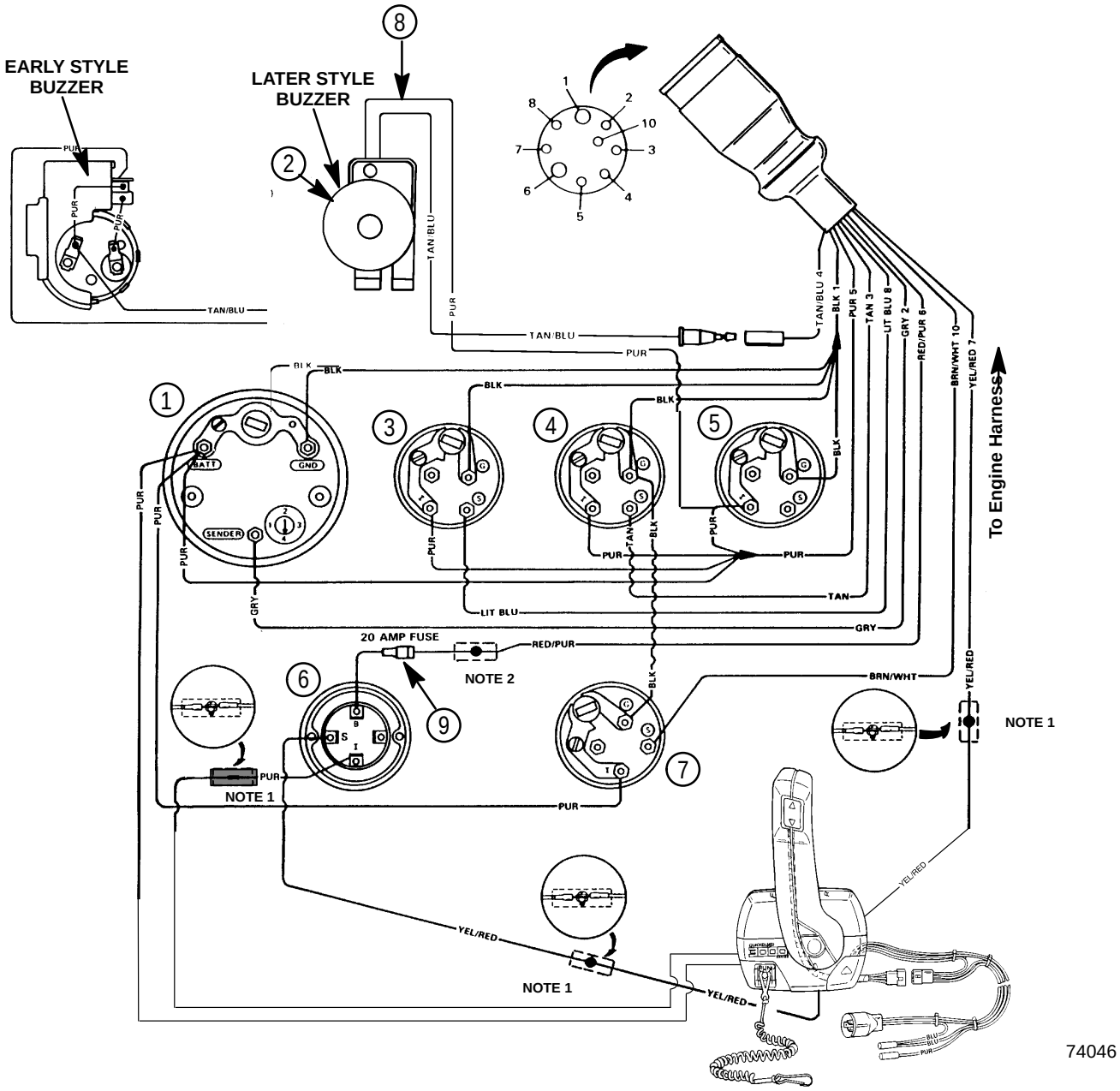


NOTE: All BLACK wires with a ground symbol are interconnected within the EFI system harness.

1 - Vapor Separator Tank (VST)
2 - Throttle Body
3 - Distributor
4 - Coil
5 - Knock Sensor (KS) Module
6 - Data Link Connector (DLC)
7 - Manifold Absolute Pressure (MAP) Sensor
8 - Knock Sensor
9 - Idle Air Control (IAC)
10- Throttle Position (TP) Sensor
11- Engine Coolant Temperature Sensor (ECT)
12- Electronic Control Module (ECM)
13- Fuel Pump Relay
14- Ignition/System Relay
15- Fuel Pump Fuse
16- ECM/Ignition Feed/KS Module/Injectors Fuse
17- ECM/DLC/Battery Fuse
18- Harness Connector To Starting/Charging Harness
19- Positive (+) Power Lead To Engine Circuit Breaker

Index

Quicksilver Instrumentation

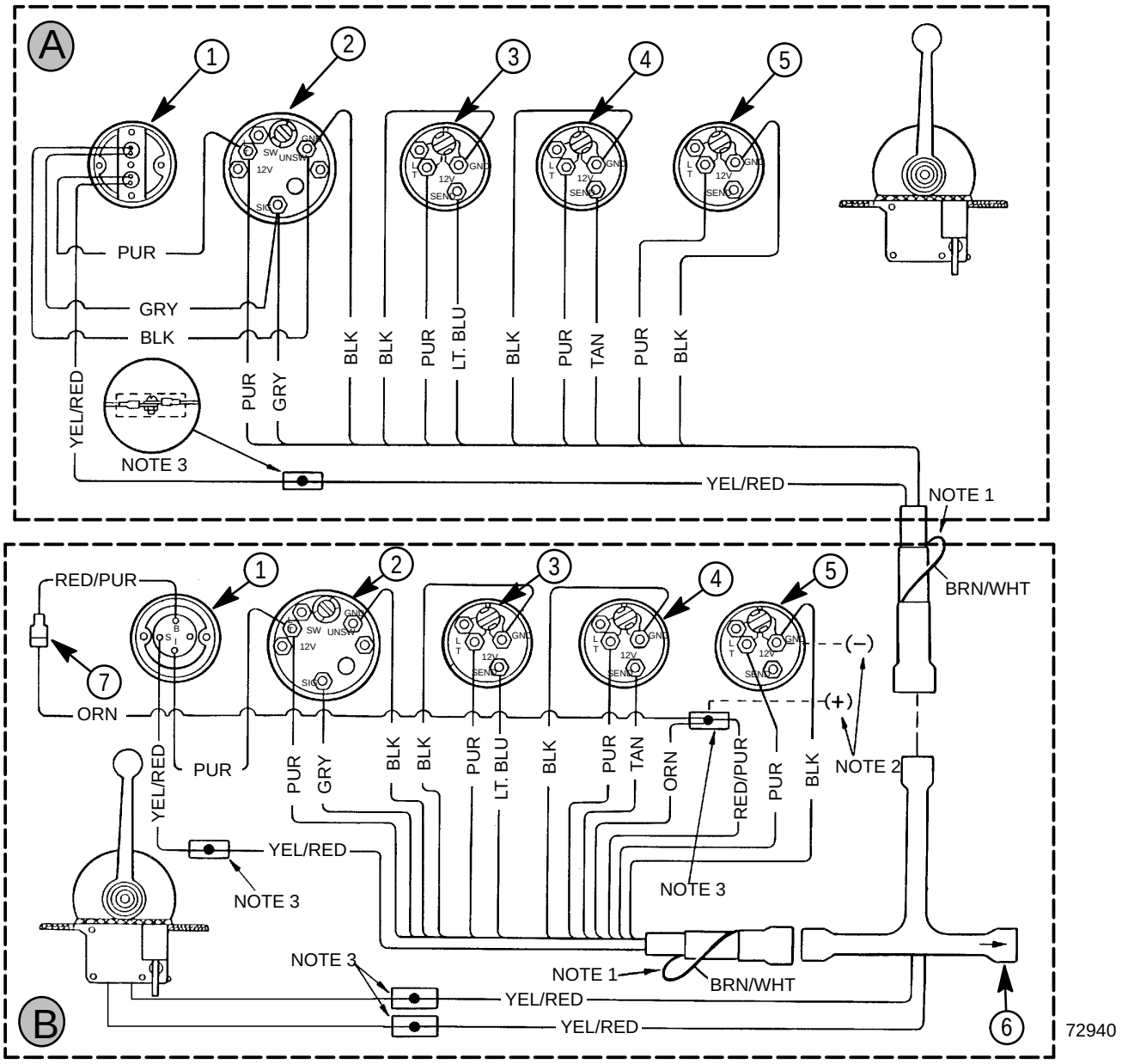


NOTE 1: Connect wires together with screw and hex nut. Apply Quicksilver Liquid Neoprene to connection and slide rubber sleeve over connection.
NOTE 2: Power for a second fused accessory panel may be taken from this connection. Load **MUST NOT** exceed 35-40 amps. Panel ground wire **MUST BE** connected to instrument terminal that has an 8 gauge BLACK (ground) harness wire connected to it.

1 - Tachometer
2 - Audio Warning Buzzer (if Equipped)
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter
6 - Ignition Switch
7 - Trim Indicator
8 - To 12 Volt Source (PURPLE wire connection)
9 - 20 Ampere Fuse

Index

Dual Station Wiring (Using a Neutral Safety Switch in Only One Remote Control)



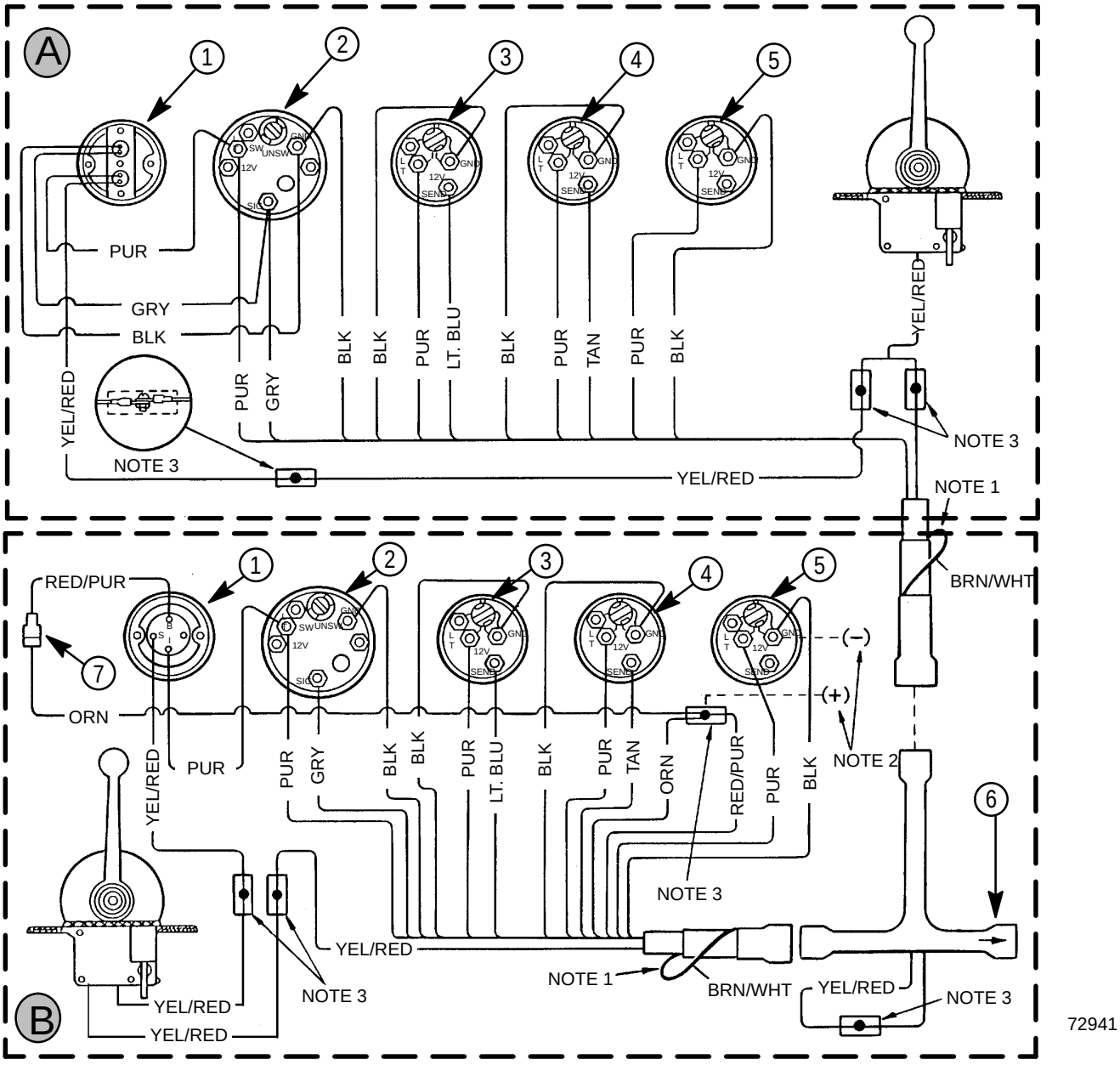
NOTE 1: BROWN/WHITE wire is taped back at instrument end. If installing on boat that is equipped with MerCruiser stern drive, BROWN/WHITE wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, BROWN/WHITE wire is taped back at engine end, or it may be used for an accessory (limit 5 amperes)
NOTE 2 : An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station **MUST NOT** exceed 35 amperes.
NOTE 3 : Connect wires together with screw and hex nut. Apply Quicksilver Liquid Neoprene to connection and slide rubber sleeve over connection.

A - Secondary Station
1 - Stop -Start Panel
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter

B - Primary Station
1 - Ignition Switch
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter
6 - To Engine
7 - 20 Ampere Fuse

Index

Dual Station Wiring (Using A Neutral Safety Switch In Both Remote Controls)



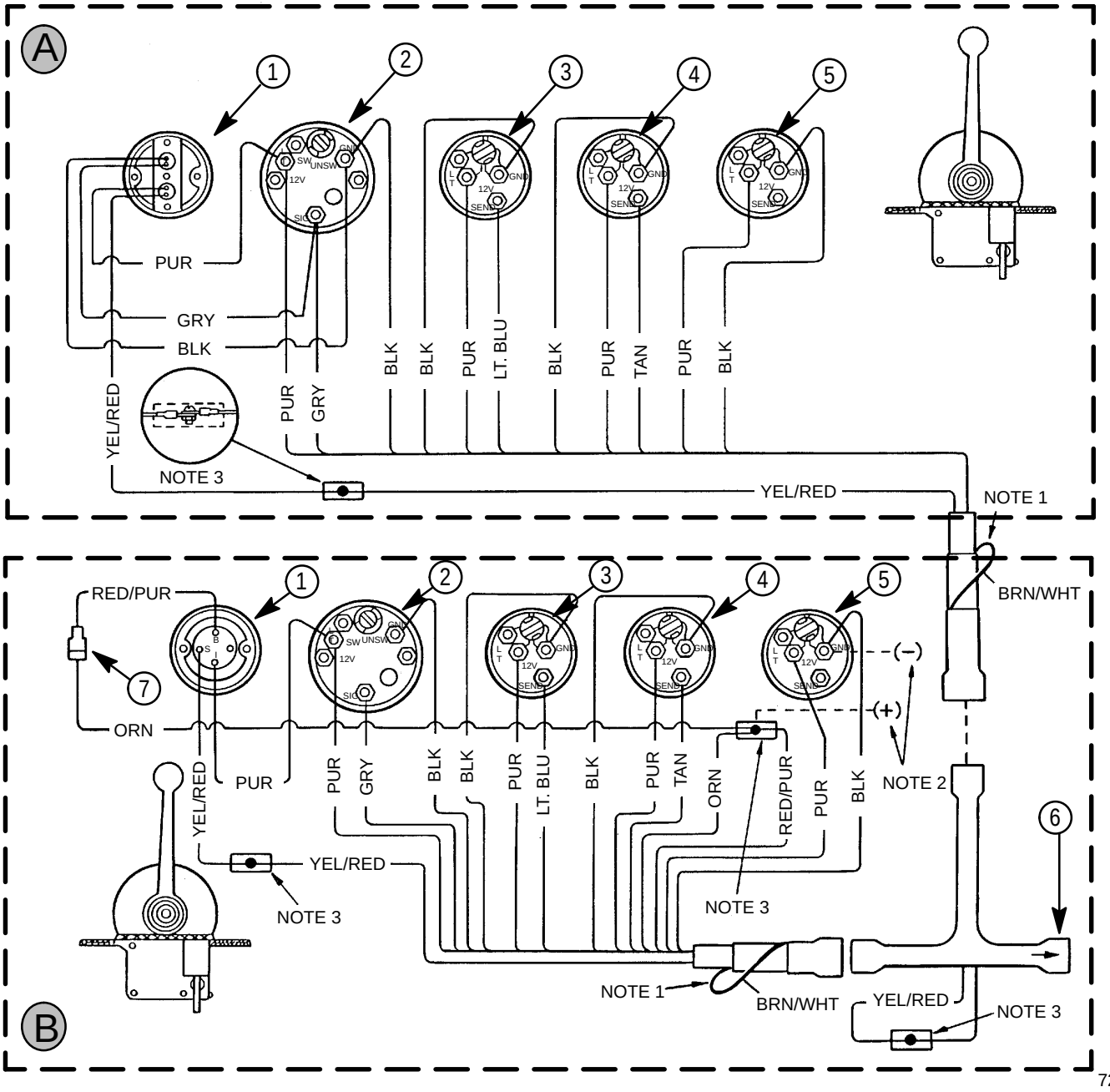
NOTE 1: BROWN/WHITE wire is taped back at instrument end. If installing on boat that is equipped with MerCruiser stern drive, BROWN/WHITE wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, BROWN/WHITE wire is taped back at engine end, or it may be used for an accessory (limit 5 amperes)
NOTE 2 : An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station **MUST NOT** exceed 35 amperes.
NOTE 3 : Connect wires together with screw and hex nut. Apply Quicksilver Liquid Neoprene to connection and slide rubber sleeve over connection.

A - Secondary Station
1 - Stop -Start Panel
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter

B - Primary Station
1 - Ignition Switch
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter
6 - To Engine
7 - 20 Ampere Fuse

Index

Dual Station Wiring (Using a Neutral Safety Switch in Engine Wiring Harness)



72942

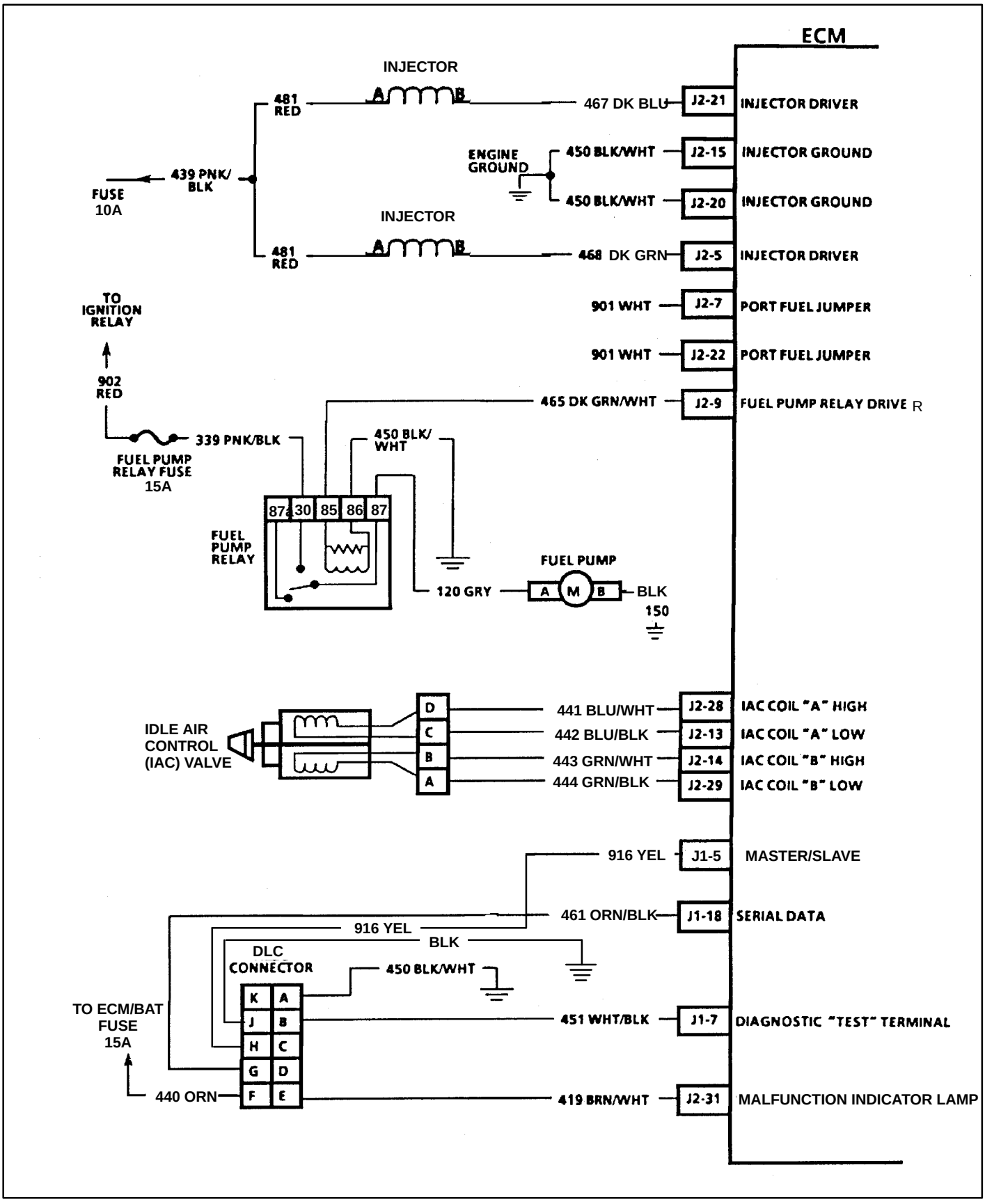
NOTE 1: BROWN/WHITE wire is taped back at instrument end. If installing on boat that is equipped with MerCruiser stern drive, BROWN/WHITE wire is connected to trim sender terminal block. If installing on MerCruiser Inboard, BROWN/WHITE wire is taped back at engine end, or it may be used for an accessory (limit 5 amperes)
NOTE 2 : An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station **MUST NOT** exceed 35 amperes.
NOTE 3 : Connect wires together with screw and hex nut. Apply Quicksilver Liquid Neoprene to connection and slide rubber sleeve over connection.

A - Secondary Station
1 - Stop -Start Panel
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter

B - Primary Station
1 - Ignition Switch
2 - Tachometer
3 - Oil Pressure
4 - Water Temperature
5 - Battery Meter
6 - To Engine
7 - 20 Ampere Fuse

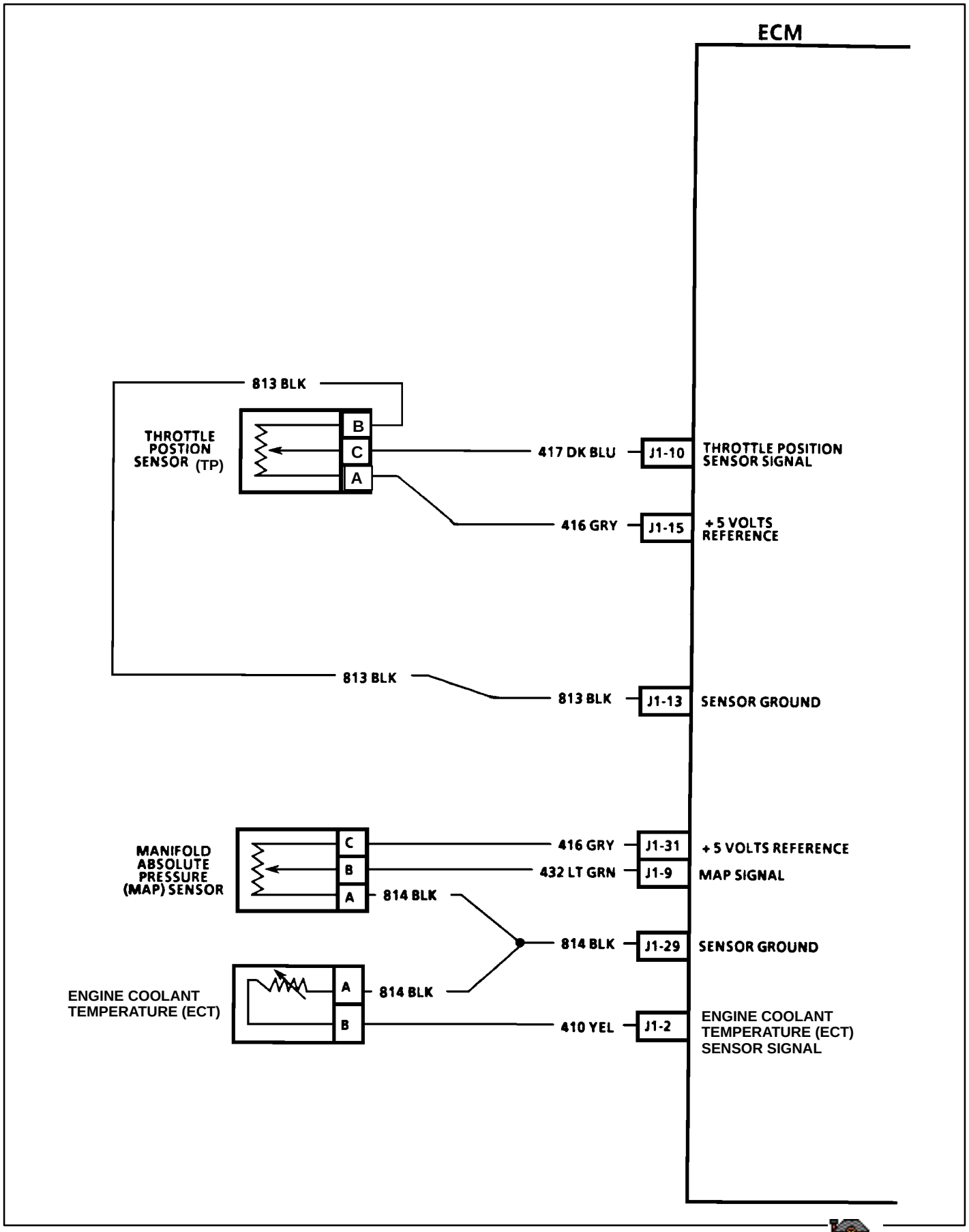
Index

EFI Wiring Diagram (Chart 1 Of 4)



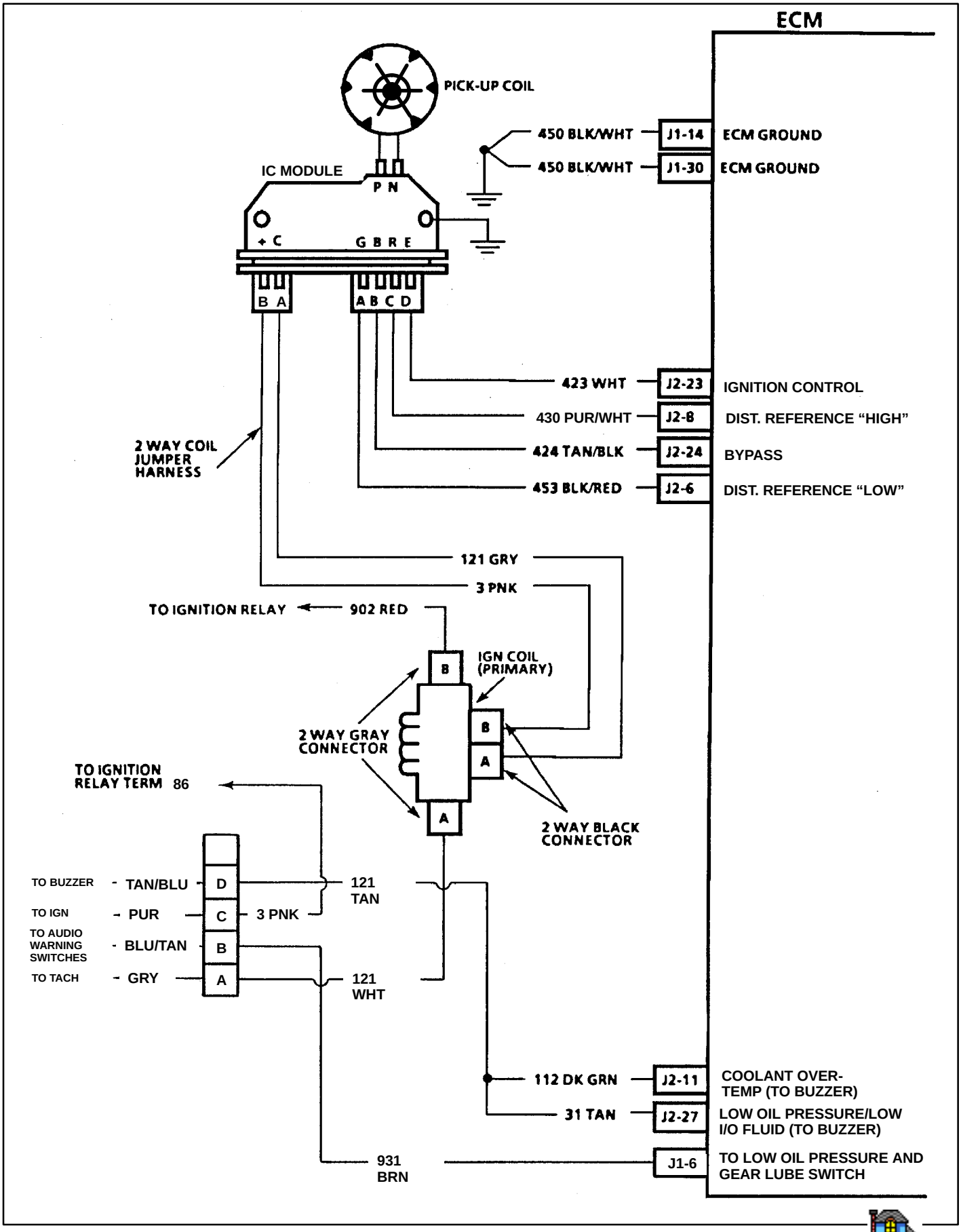
Index

EFI Wiring Diagram (Chart 2 Of 4)



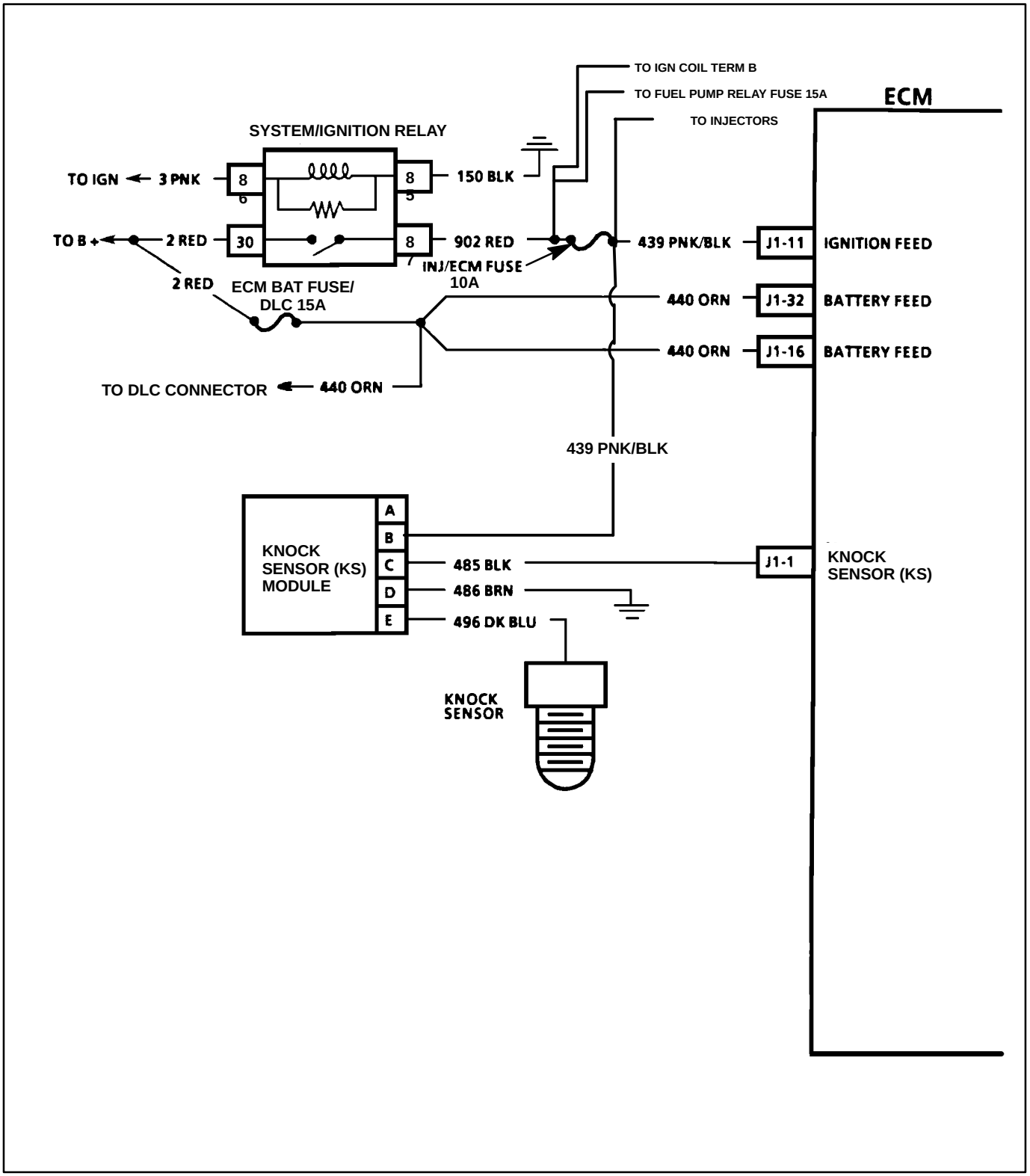
Index

EFI Wiring Diagram (Chart 3 Of 4)



Index

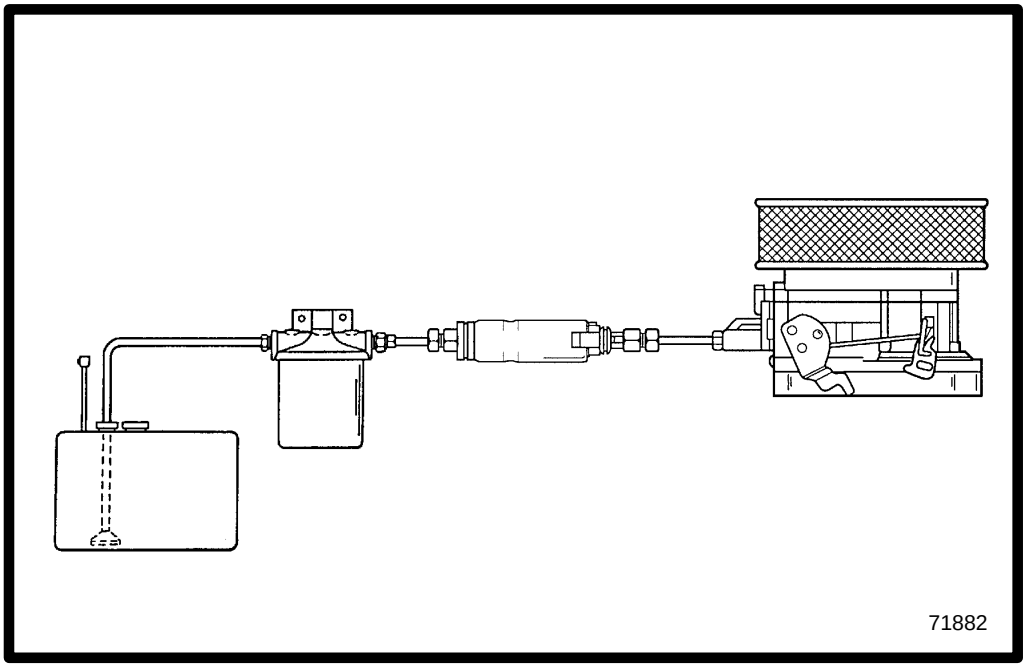
EFI Wiring Diagram (Chart 4 Of 4)



Index

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

FUEL SYSTEMS



5

A

FUEL DELIVERY SYSTEM

Index

Table of Contents

	Page
Torque Specifications	5A-1
Special Tools	5A-1
Lubricants, Sealers and Adhesives	5A-1
Specifications	5A-1
Identification	5A-1
Replacement Parts Warning	5A-2
Fuel Supply Connections	5A-2
Precautions	5A-2
Fuel Delivery System	5A-3
Recommendations	5A-3
Description	5A-3
Fuel System Components (Carburetor)	5A-3
Water Separating Fuel Filter	5A-3
Replacement	5A-5
Testing Fuel Pump	5A-5
Electric Fuel Pump For Carbureted and VST Equipped Engine	5A-5
Replacement	5A-5
Fuel System For Carbureted Engines	5A-8
VST System for Throttle Body Injection	5A-9
Cool Fuel System For Throttle Body Injection	5A-9

Index

262 CID / 4.3L

Torque Specifications

DESCRIPTION	Lb. In.	Lb. Ft.	N·m
Fuel Pump Bracket to Cylinder Head		25	34
Fuel Lines		18	24
Fuel Filter Brackets Bolt		25	34
Fuel Pump Outlet Brass Coupling (Small)	84		9.5
Fuel Pump Outlet Brass Coupling (Large)	96		10.6
Water Separating Fuel Filter Fittings	Tighten finger tight then 1-3/4 to 2-1/4 turns with wrench (See Note)		

Note: Apply #592 Loctite Pipe Sealant with Teflon. DO NOT use Teflon Tape.

Special Tools

DESCRIPTION	PART NUMBER
Fuel Pressure Connector - Carb	91-18078
Fuel Pressure Gauge	91-16850A1

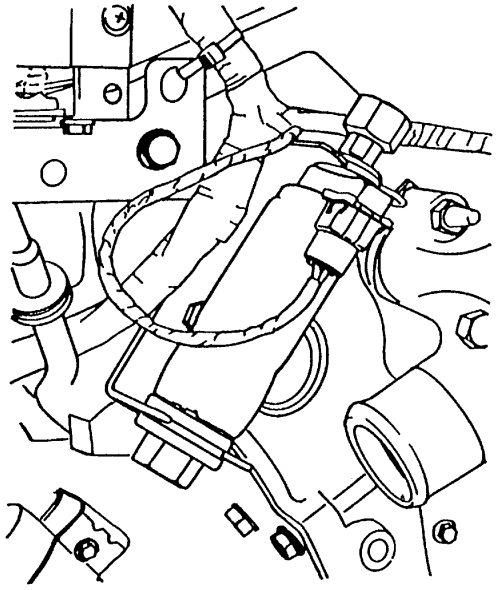
Lubricants, Sealers and Adhesives

DESCRIPTION	PART NUMBER
Loctite Pipe Sealant with Teflon	Obtain Locally

Specifications

DESCRIPTION	SPECIFICATION
Pump Pressure	3-7 PSI (21-48 kPa)

Identification



71292

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Fuel Supply Connections

⚠WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

Precautions

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or flame in the area while changing fuel filters. Wipe up any spilled fuel immediately.

⚠WARNING

Make sure that no fuel leaks exist before closing engine hatch.

⚠CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged and subsequent overheating damage may result.

⚠CAUTION

The electric fuel pump and water separating fuel filter have been carefully designed to function properly together. Do not install additional fuel filters and/or water separating fuel filters between fuel tank and engine.

The installation of additional filters may cause:

- **Fuel Vapor Locking**
- **Difficult Warm-Starting**
- **Piston Detonation Due to Lean Fuel Mixture**
- **Poor Driveability**

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

Fuel Delivery System

Recommendations

⚠ WARNING

Boating industry standards (BIA, ABYC, etc.) federal standards and Coast Guard regulations MUST BE adhered to when installing fuel delivery system.

When designing and installing fuel delivery system, the following information MUST BE observed:

1. Fuel tank should be mounted below carburetor level, if possible. If tank is mounted above carburetor level, gravity feed may cause carburetor fuel inlet needle to unseat, and flooding may result.
2. Fuel pickup should be at least 1 in. (25 mm) from the bottom of the fuel tank to prevent picking up water or other impurities.
3. Fuel lines used MUST BE Coast Guard approved (USCG type A) and MUST NOT BE SMALLER THAN 3/8 in. (9.5 mm) I.D. On installations where long lines or numerous fittings are required, larger size lines should be used.
4. Fuel line should be installed free of stress and firmly secured to prevent vibration and/or chafing.
5. Sharp bends in fuel line should be avoided.
6. A flexible fuel line must be used to connect fuel line to engine to absorb deflection when engine is running.

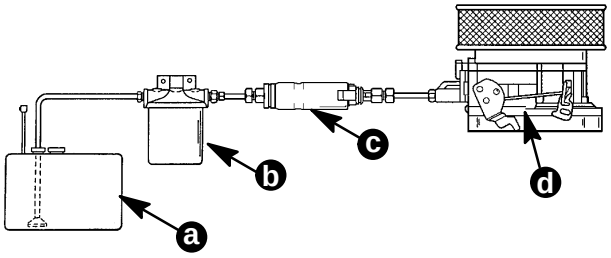
Description

The fuel system consists of fuel tank(s), a water separating fuel filter, an electric fuel pump and a carburetor.

The fuel is stored in the fuel tank. When the fuel pump is energized by turning on ignition switch, fuel is drawn from the fuel tank, through the water separating filter, by the electric fuel pump.

The fuel is pushed through the fuel line to the carburetor where it is metered and supplied to the engine.

Fuel System Components (Carburetor)



50830 72982

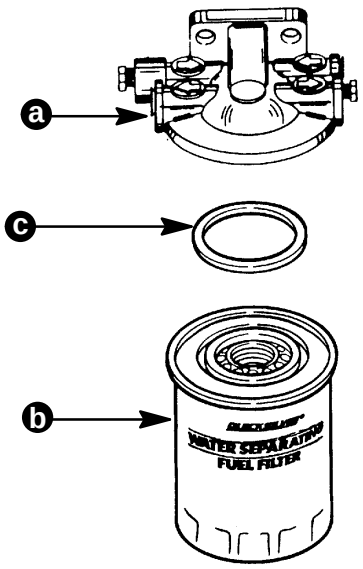
a - Fuel Tank
b - Water Separating Fuel Filter
c - Electric Fuel Pump
d - Carburetor

Water Separating Fuel Filter

NOTICE
Refer to "Precautions," in this section, BEFORE proceeding.

The water separating fuel filter is standard with the electric fuel pump on all V-6 engines.

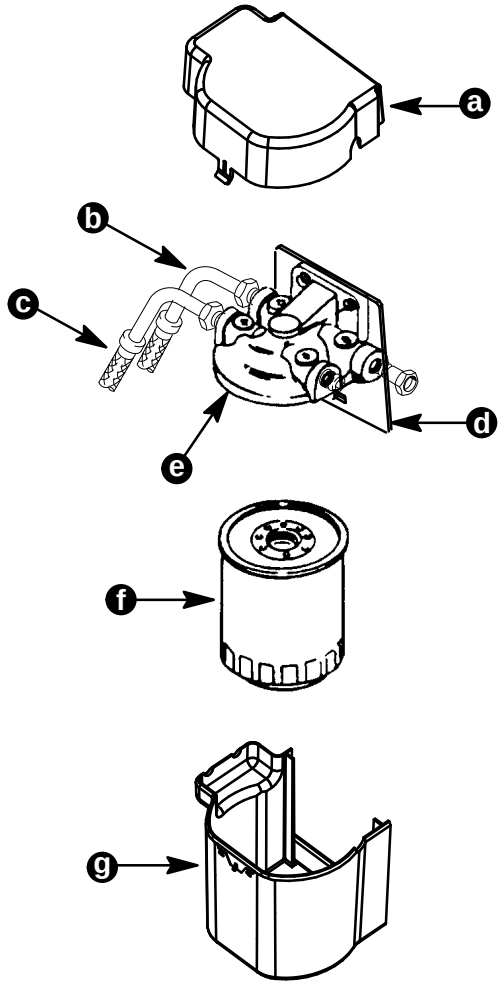
The fuel filter consists of the fuel filter base and filter element.



72678

Carbureted and VST Equipped Fuel Injected Engines

a - Filter Mounting Bracket
b - Filter Element
c - Sealing Ring



Cool Fuel System Engines

a - Top Cover
b - Outlet Line
c - Return Line
d - Backing Plate
e - Filter Mounting Bracket
f - Filter Element
g - Bottom Cover

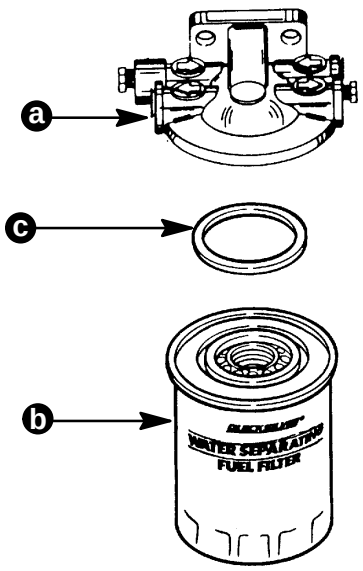
Filter should be replaced when fuel flow is restricted or filter flow is questionable. DO NOT attempt to flush out filter.

Replacement

NOTICE

Refer to "Precautions," in this section, BEFORE proceeding.

1. Disconnect battery cables from battery.
2. Remove fuel filter from base. A filter wrench may be needed to loosen element.
3. Lubricate sealing ring(s) of new filter with SAE engine oil.
4. Install new filter, tightening securely by hand.
5. Reconnect battery cables. Make sure water is supplied to cooling system and start engine. Check for fuel leaks.



72678

a - Filter Base/Mounting Bracket
b - Filter Element
c - Sealing Ring

Testing Fuel Pump

1. Disconnect battery cables from battery.
2. Remove fuel line from carburetor or outlet side of fuel pump.
3. Install Fuel Pressure Connector (91-18078) to carburetor or fuel pump and reinstall fuel line. Tighten connector and fuel line securely.
4. Connect fuel pressure test gauge to connector.
5. Reconnect battery cables, start engine, and run at idle, making sure water is supplied to the cooling system.
6. Fuel pressure should be within specifications. If not, replace fuel pump.

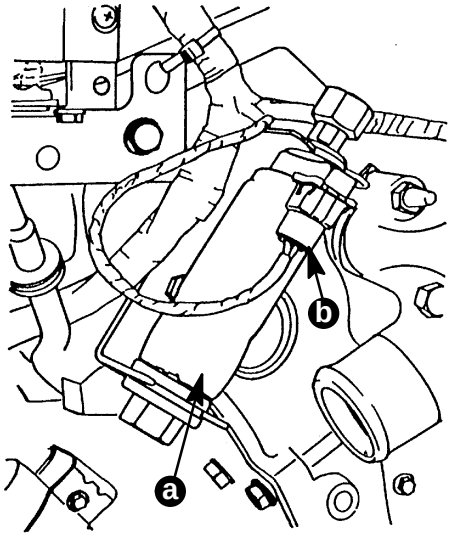
Electric Fuel Pump For Carbureted and VST Equipped Engine

NOTICE

Refer to "Precautions," in this section, BEFORE proceeding.

Replacement

IMPORTANT: The electric fuel pump cannot be repaired. If pump fails, it must be replaced.



71292

Carburetor and VST Equipped Models

a - Fuel Pump
b - Wiring Harness

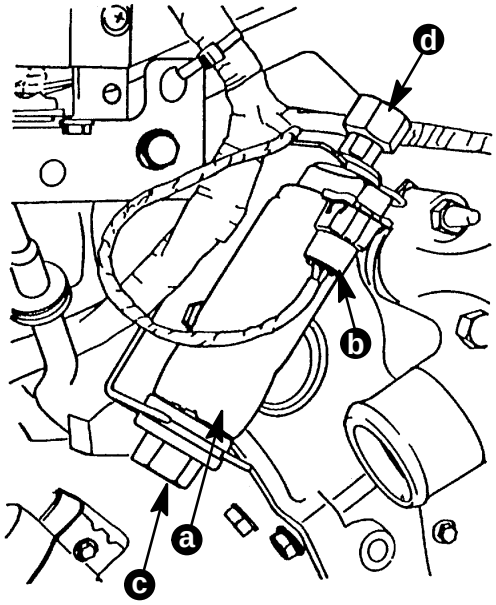
REMOVAL

1. Disconnect battery cables from battery.

⚠CAUTION

Plug fuel supply hose after removal to prevent fuel from leaking into boat.

2. Using wrench to stabilize fuel pump inlet and outlet couplings, loosen and remove upper and lower fuel line connectors. Carefully move fuel lines enough to clear pump.



71292

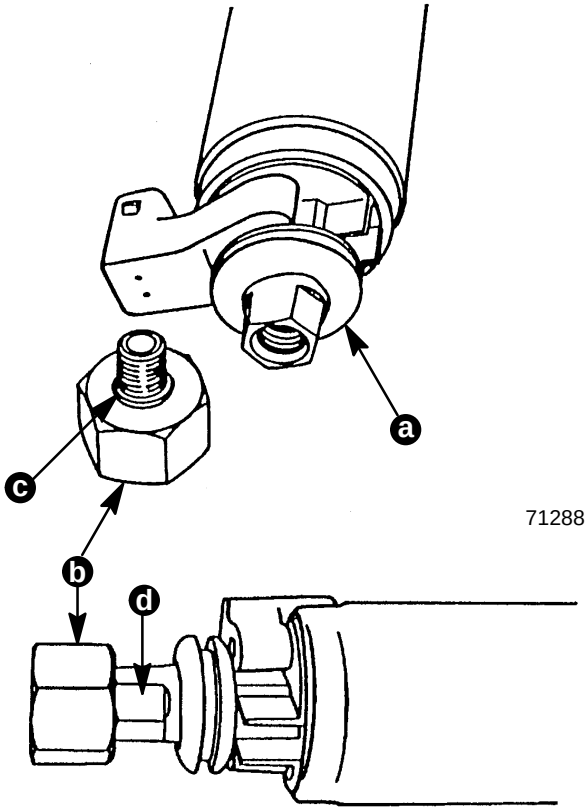
a - Fuel Pump
b - Wiring Harness
c - Inlet Coupling (Large)
d - Outlet Coupling (Small)

3. Unplug wiring harness at fuel pump connection.

4. Remove fuel pump by pulling out of bracket.

INSTALLATION

1. Install small diameter rubber grommet on outlet side of fuel pump. Install O-ring on outlet fitting and install fitting on pump. Use the flat surface on pump outlet to hold pump while tightening. Torque to 84 lb. in. (9.5 N·m).

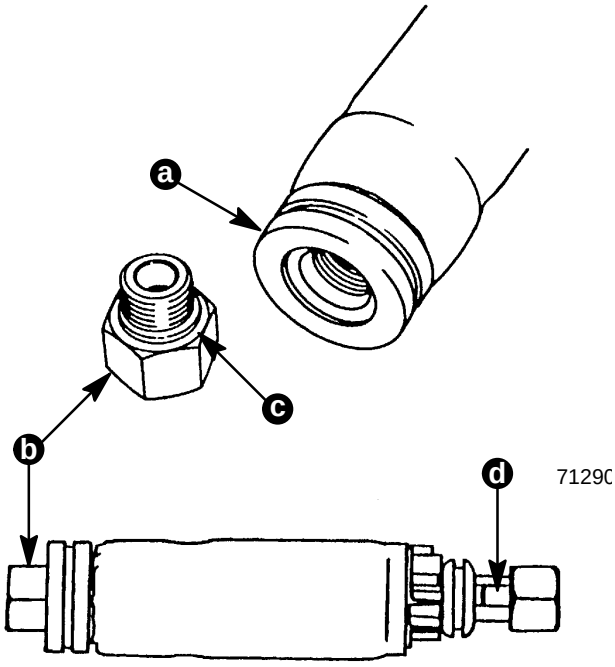


71288

71289

a - Small Diameter Rubber Grommet
b - Outlet Fitting
c - O-Ring
d - Flat (Hold with Wrench)

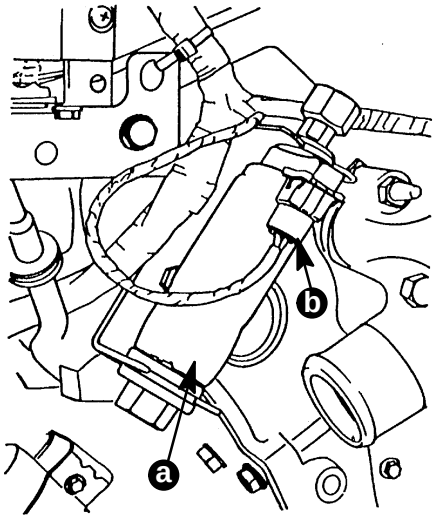
2. Install large diameter rubber grommet on inlet side of fuel pump. Install O-ring on inlet fitting and install fitting on pump. Use the flat surface on pump outlet to hold pump while tightening. Torque fitting to 96 lb. in. (10.8 N·m).



71291

a - Large Diameter Rubber Grommet
b - Inlet Fitting
c - O-Ring
d - Flat (Hold with Wrench)

3. Install fuel pump in bracket and connect wiring harness.



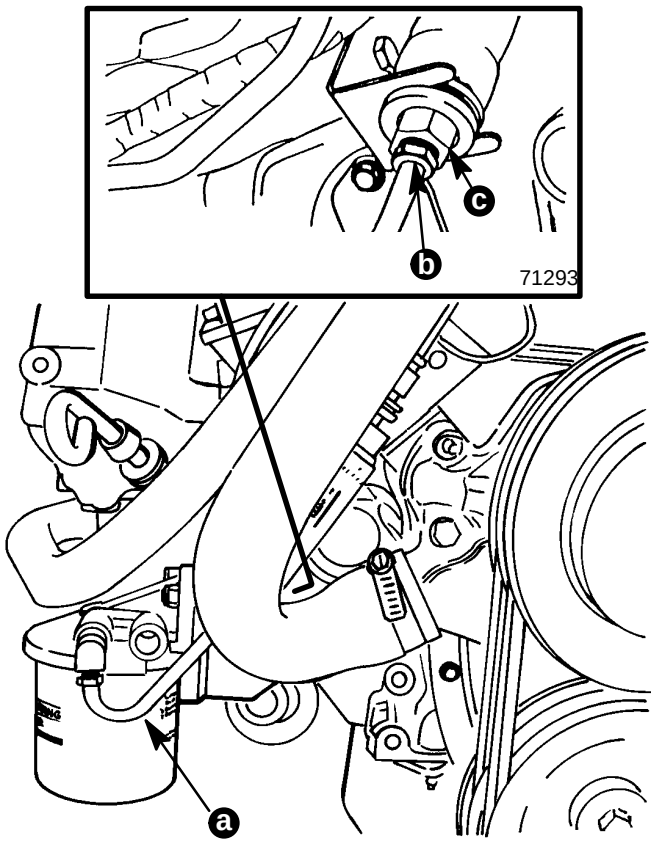
71292

a - Fuel Pump
b - WIring Harness

⚠CAUTION

Avoid damage to electric fuel pump. Securely hold lower and upper fuel pump fittings with suitable wrench when tightening fuel line fittings.

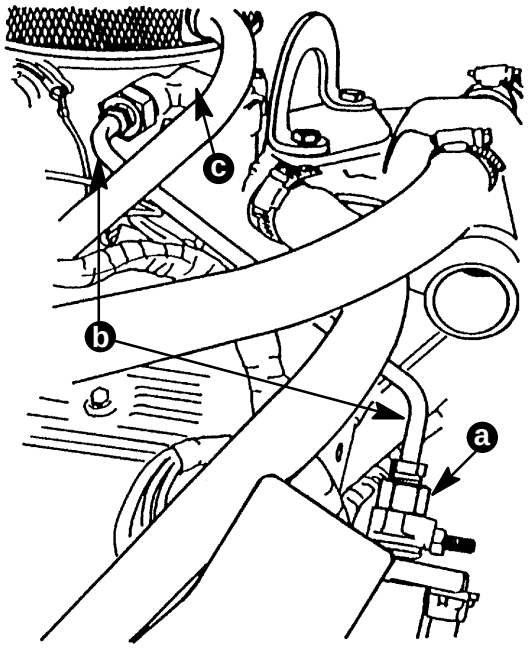
4. Connect lower fuel line at pump. Hold fuel pump fitting with a suitable wrench and securely tighten fuel line fitting.



71880

a - Lower Fuel Line
b - Lower Fuel Line Connection at Pump
c - Fuel Pump Inlet Brass Coupling (Large)

5. Connect upper fuel line at fuel pump outlet. Hold fuel pump brass coupling with a suitable wrench and securely tighten fuel line fitting. Check that connections at fuel filter outlet coupling and at carburetor inlet coupling are tightened securely.



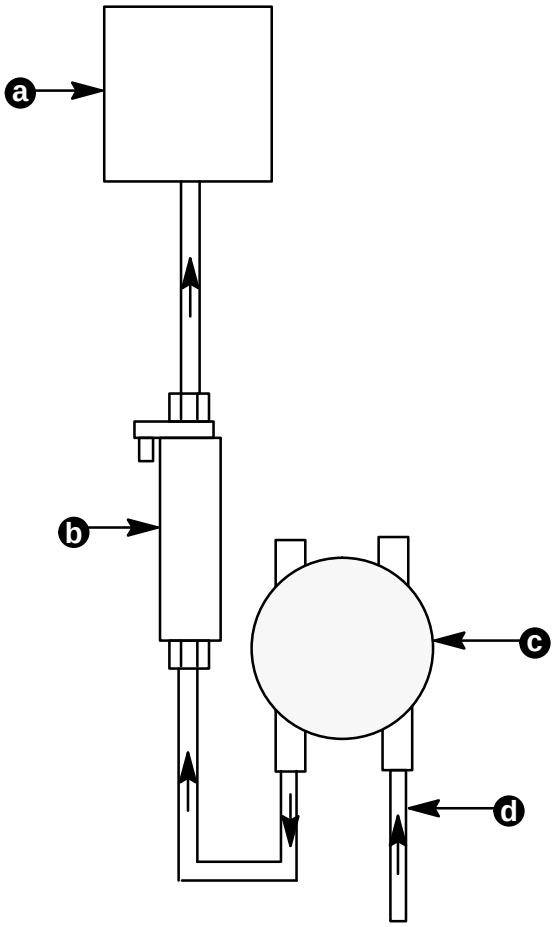
71294

a - Upper Fuel Line
b - Fuel Pump Outlet (Brass Connector)
c - Carburetor

6. Reconnect battery cables to battery.

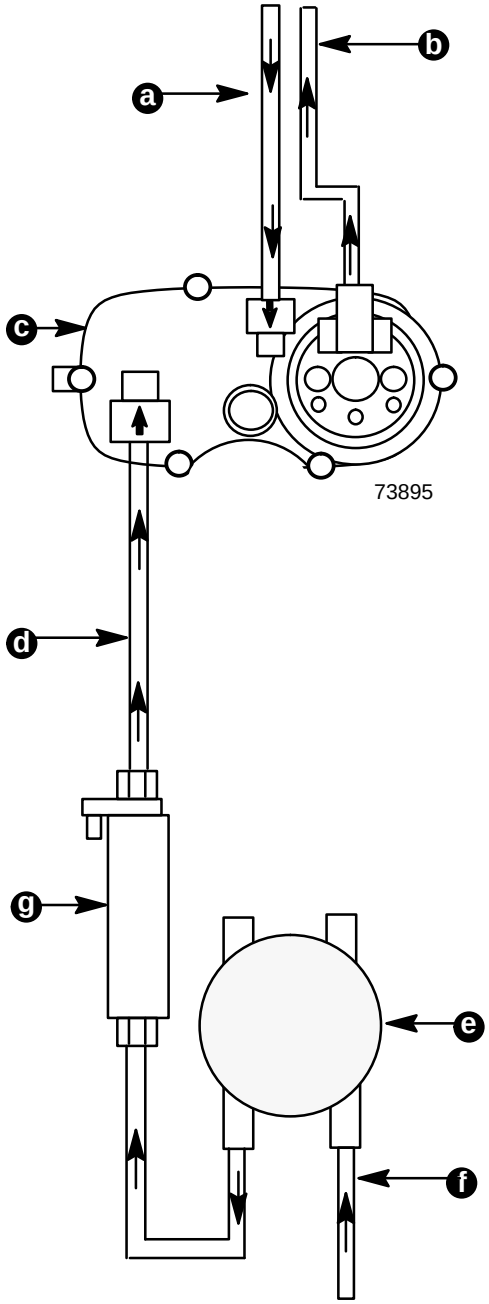
7. Inspect all fuel system lines and fittings for leaks when first starting engine.

Fuel System For Carbureted Engines



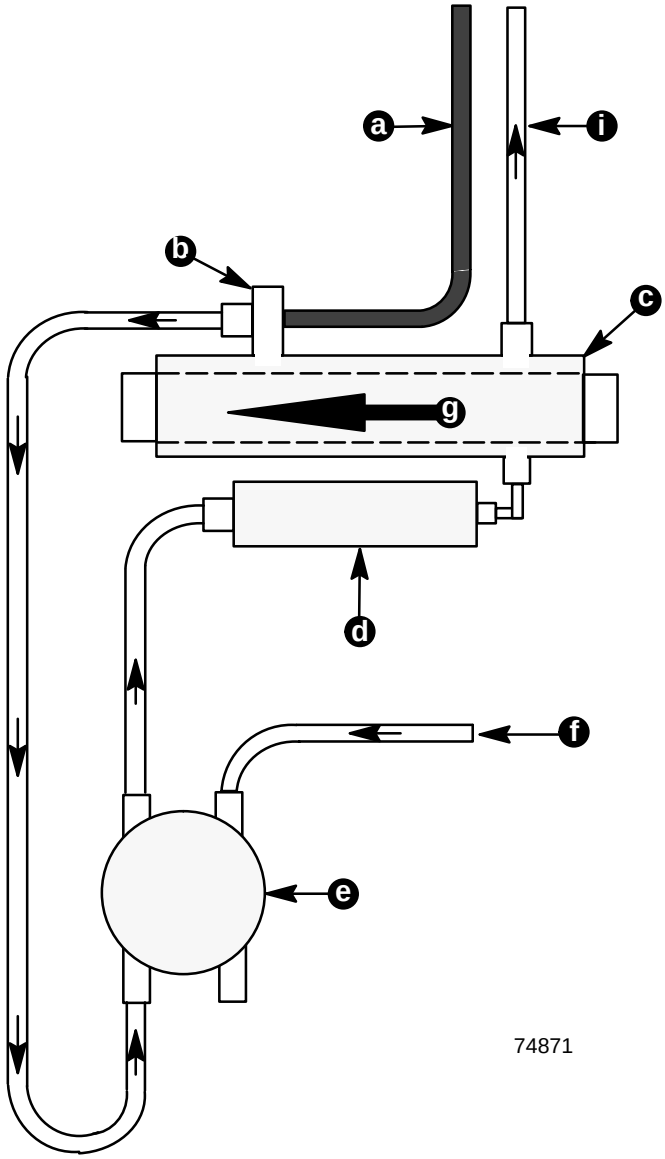
a - 2 Barrel MerCarb Or Weber 4 Barrel Carburetor
b - Electric Lift Pump
c - Water Separating Fuel Filter
d - Fuel Line From Boat Fuel Tank

VST System for Throttle Body Injection



a - Outlet Fuel Line
b - Return Fuel Line
c - Vapor Separator Tank (VST)
d - Fuel Line From Water Separating Fuel Filter
e - Water Separating Fuel Filter
f - Fuel Line From Tank
g - Electric Lift Pump

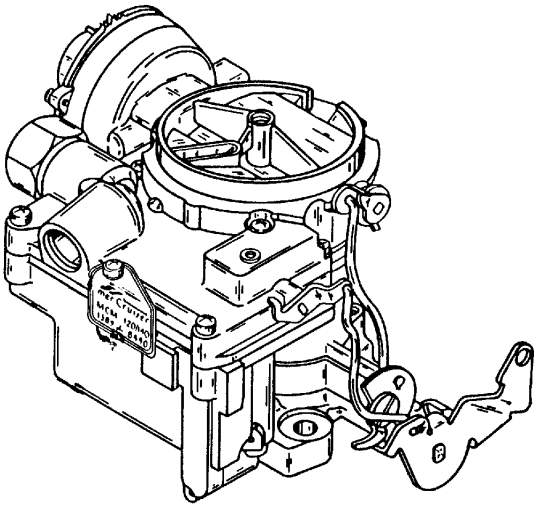
Cool Fuel System For Throttle Body Injection



a - Reference Line To Flame Arrestor
b - Fuel Pressure Regulator
c - Fuel Cooler
d - Electric Fuel Pump
e - Water Separating Fuel Filter
f - Fuel From Tank
g - Direction Of Water Flow
h - Throttle Body Unit
i - Fuel Line To Throttle Body
j - Excess Fuel Return To Water Separating Fuel Filter

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

FUEL SYSTEM



72681

5

B

MERCARB® 2 BARREL CARBURETOR

Index

Table of Contents

	Page
MerCarb 2 BBL Carburetor	5B-1
Torque Specifications	5B-1
Tools	5B-1
Specifications	5B-1
Exploded View	5B-2
Identification	5B-4
Important Service Information	5B-4
Flooding at Idle RPM	5B-4
Needle/Seat Change	5B-4
Adjustable Accelerator Pump Lever	5B-5
High Altitude Re-Jetting	5B-5
Description	5B-5
Precautions	5B-6
Maintenance	5B-6
Flame Arrestor with Carburetor Cover	5B-6
Fuel Inlet Filter	5B-7
Choke Inspection	5B-8
Adjustments	5B-8
Pump Rod	5B-8
Choke Setting	5B-9
Choke Unloader	5B-9
Preliminary Idle Speed and Mixture	5B-9
Final Idle Speed and Mixture	5B-10
Repair	5B-11
Removal	5B-11
Installation	5B-11
Disassembly	5B-12
Choke Housing Assembly	5B-12
Air Horn Assembly	5B-12
Float Bowl Assembly	5B-15
Throttle Body Assembly	5B-16
Cleaning and Inspection	5B-17
Reassembly	5B-18
Throttle Body Assembly	5B-18
Float Bowl Assembly	5B-19
Air Horn Assembly	5B-21
Float Level	5B-22
Float Drop	5B-23
Choke Housing Assembly	5B-25

Index

MerCarb 2 BBL Carburetor

Units of Measurements
In. (mm)

00000

Torque Specifications

DESCRIPTION	LB. FT.	N·m
Carburetor To Manifold	20	27
Fuel Line to Carburetor	18	24
Fuel Inlet Filter Nut	18	24

Tools

DESCRIPTION	PART NUMBER
Universal Carburetor Gauge	91-36392
Boroughs Special Tool and Equipment Inc. 2429 N. Burdick Street Kalamazoo,MI 49007 (616) 345-5163	
Float Gram Scale	BT 8128 B

Specifications

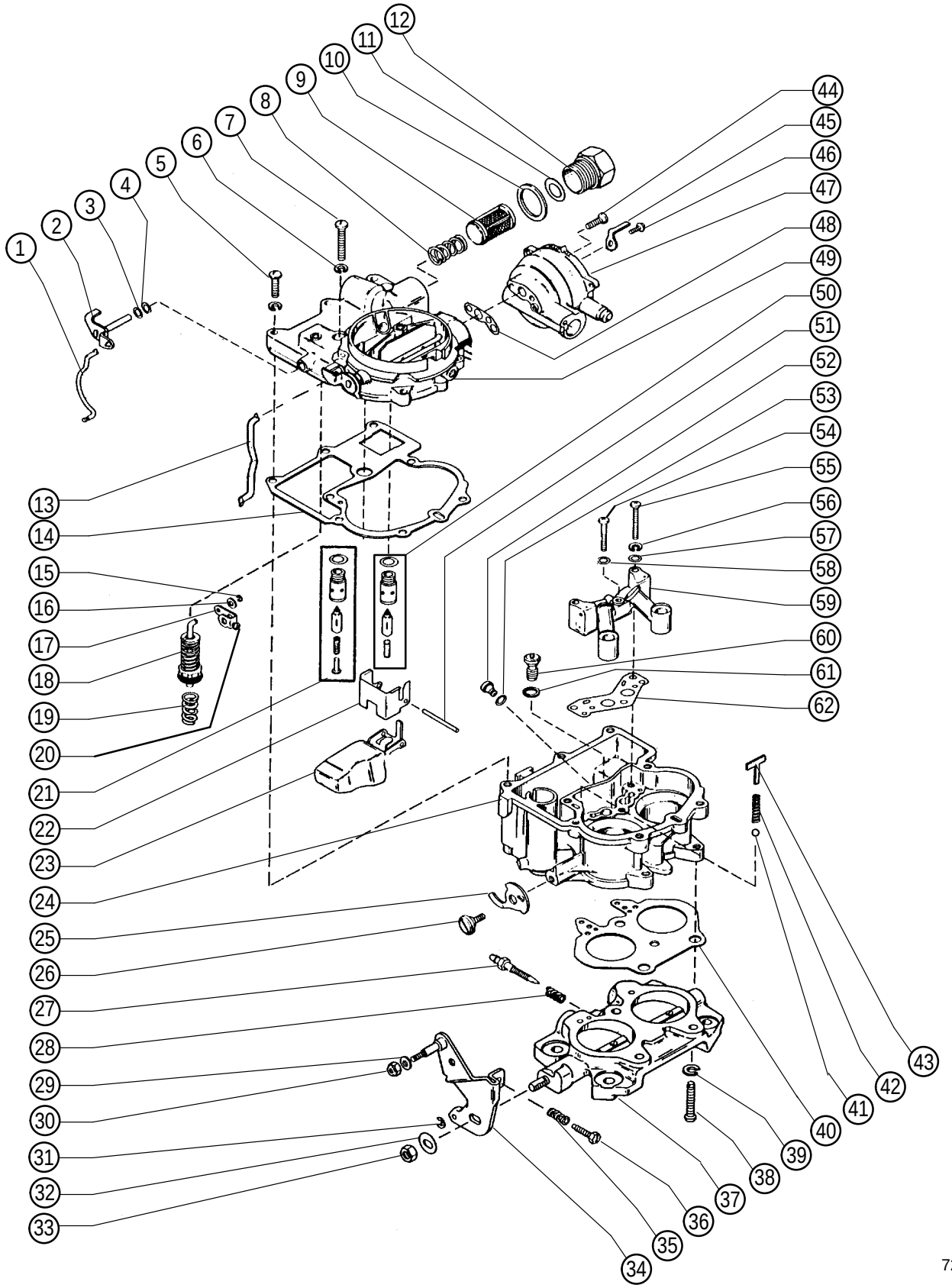
Units of Measurements
In. (mm)

ENGINE MODEL	4.3L With Thunderbolt IV Ignition		4.3LX Gen + With Thunderbolt V Ignition
Carburetor Type	MerCarb 43mm		
Carburetor Number	3310-806080A-1	3310-806972	3310-807764
Float Level	9/16 (14) Note 1		
Float Drop	1-3/32 (27) Note1		
Pump Rod (Location)	Middle Hole Of Pump Arm		
Choke Setting	2 Marks Right Of Index Mark (Lean)		
Choke Unloader	5/64 [.080] (2)		
Idle Mixture Screw	1-1/4 Turns Out		
Float Weight	9 Grams Maximum		
Main Jet Size	1.60 mm	1.55 mm	
Power Valve Size	0.74 mm		
Venturi Cluster I.D. Number	421	466	472
Accelerator Pump Discharge Hole Size	0.035 (0.90)		

Note: 1 Measurement taken from gasket

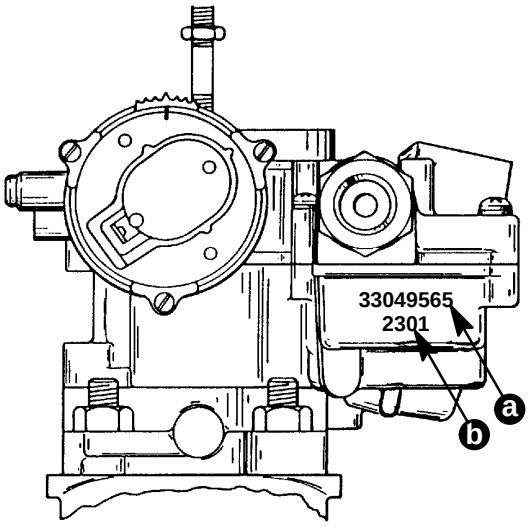
Index

Exploded View



1 - Rod - Accelerator Pump
2 - Accelerator Pump Shaft and Lever Assembly
3 - Washer (Outer)
4 - Washer (Inner)
5 - Screw
6 - Washer
7 - Screw
8 - Spring
9 - Filter
10- Gasket
11- Gasket
12- Nut-Fuel Inlet
13- Choke Rod
14- Gasket
15- Clip - Retainer
16- Washer
17- Pump Shaft and Lever Assembly
18- Accelerator Pump Assembly
19- Screw
20- Screw
21- Inlet Needle and Seat (Spring Loaded - Optional)
22- Baffle Plate
23- Float
24- Float Bowl
25- Cam-Idle
26- Screw
27- Idle Mixture Adjusting Needle
28- Spring
29- Washer
30- Nut
31- Clip-Pump Rod
32- Washer-Locking
33- Nut
34- Throttle
35- Spring
36- Screw - Idle Speed Adjustment
37- Throttle Body
38- Screw
39- Washer
40- Gasket
41- Check Ball
42- Spring
43- Retainer
44- Screw
45- :ever Assembly
46- Screw
47- Choke/Housing
48- Gasket
49- Air Horn
50- Inlet Needle and Seal
51- Pin
52- Screw
53- Gasket
54- Screw
55- Screw
56- Flat Washer
57- Lock Washer
58- Gasket
59- Venturi Cluster
60- Power Valve Assembly
61- Gasket
62- Gasket

Identification



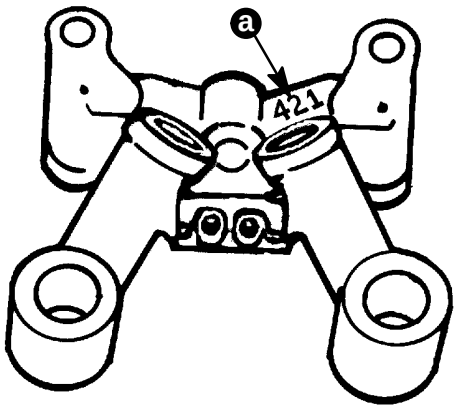
72680

Carburetor Part Number Location

a - Part Number
b - Date Code

Data Code Explanation: Example 2301

First Figure is Year:
2 = 1992, 3 = 1993, etc.
Second Figure is Month:
2 = February, 3 = March, etc.
X = October, Y = November, Z = December
Third and Fourth Figures are Day of Month:
01 = First day, 02 = Second day, etc.



72779

Venturi Cluster Identification

c - Identification Number (See Specifications)

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Important Service Information

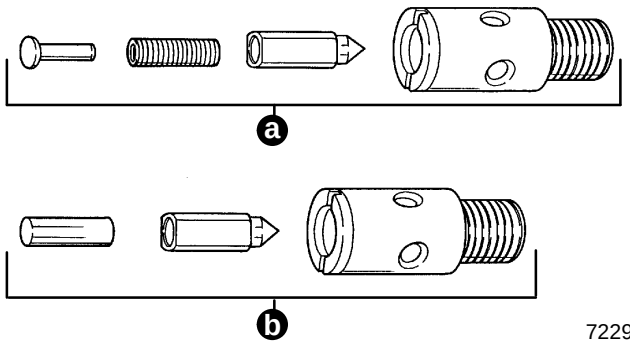
Flooding at Idle RPM

If your engine floods at idle RPM, check the following:

1. Problem in ignition system causing engine to run rough.
2. Idle mixture screw adjusted incorrectly.
3. Bad needle and seat.
4. Incorrect float level drop.

Needle/Seat Change

If the preceding steps failed to correct the problem, change the needle/seat to the other type. MerCarbs are equipped with either the solid or the spring loaded needle.



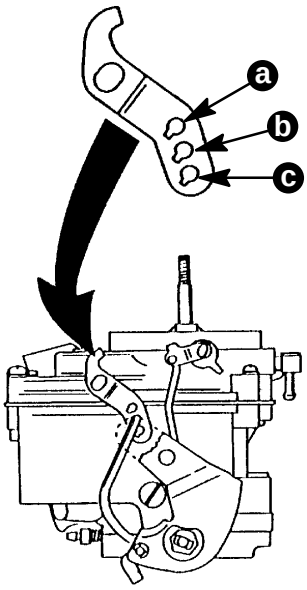
72290

Needle and Seat Assemblies

a - Spring Loaded Type Needle (Kit - 3302-9029)
b - Solid Type Needle (3302-9407)

Adjustable Accelerator Pump Lever

This new lever with will allow you to change the amount of fuel delivered to the engine by the accelerator pump. The hole closest to the lever's shaft will give the same amount of fuel as the single hole lever did. The center hole gives approximately 0.5 cc less fuel and the hole farthest away will give about 1.0 cc less
fuel.



73131

a - Full Accelerator Pump Stroke
b - 0.5 cc Less Fuel Per Stroke
c - 1.0 cc Less Fuel Per Stroke

The technician should be able to correct most "bogging" problems with this 3-hole lever, providing the "bogging" is caused by the carburetor. When installing the 3-hole lever, remove any metal ball that someone may have put in the accelerator pump well to limit pump travel. Also, make sure that the duration spring on the accelerator pump is stock and hasn't had several coils cut off. Make sure the venturi cluster is the correct one as outlined previously under "Specifications"

High Altitude Re-Jetting

Engine flooding problems, at idle RPM, are generally related to the altitude (above sea level) at which they are operated.

If engine is running too rich at higher elevation, order a smaller jet from the chart. A jet stamped "165" is a 1.65 mm jet.

Jet Size (mm)	Quicksilver Part Number
1.30	3302-811849
1.35	3302-811850
1.40	3302-811851
1.45	3302-9050
1.50	3302-811852
1.55	3302-811853
1.60	3302-810923
1.65	3302-9058
1.70	3302-9055
1.75	3302-811854
1.80	3302-811855
1.85	3302-811856
1.90	3302-811857

Description

This MerCarb carburetor is a two bore carburetor and has a separate fuel feed for each venturi. This model also is equipped with an electric choke. A removable venturi cluster (secured to float bowl assembly) has the calibrated main well tubes and pump jets built into it. The venturi cluster is serviced as a unit. The serviceable main metering jets are bleeds to properly meter the correct fuel/air mixture to the engine.

Precautions

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠WARNING

Make sure no fuel leaks exist, before closing engine hatch.

Fuel Supply Connections

⚠CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

Maintenance

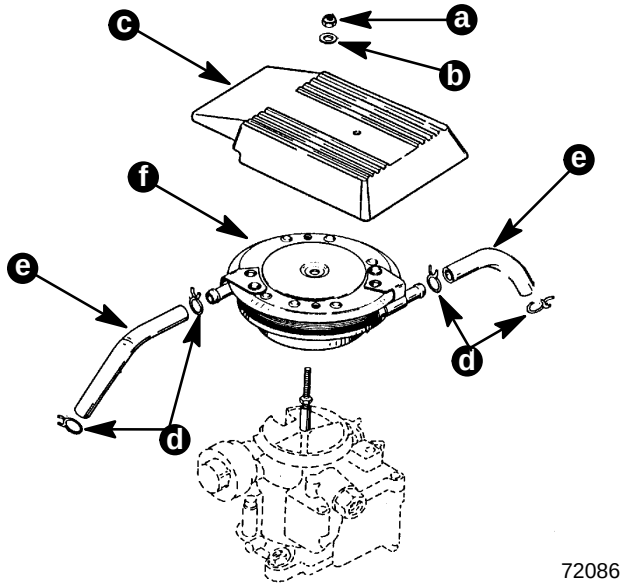
Flame Arrestor with Carburetor Cover

NOTICE

Refer to “Precautions,” in this section, BEFORE proceeding.

1. Remove in the following order:
   a. Nut.
   b. Sealing washer.
   c. Carburetor cover.
   d. Crankcase ventilation hoses from flame arrestor and rocker arm covers.
   e. Flame arrestor.
2. Clean and inspect:
   a. Clean flame arrestor in solvent and blow dry with compressed air.
   b. Clean crankcase ventilation hoses.
   c. Inspect crankcase ventilation hoses for cracks or deterioration, and replace if necessary.

3. Install in the following order:
   a. Flame arrestor.
   b. Crankcase ventilation hoses to flame arrestor and rocker arm covers.
   c. Carburetor cover.
   d. Sealing washer.
   e. Nut (tighten securely).



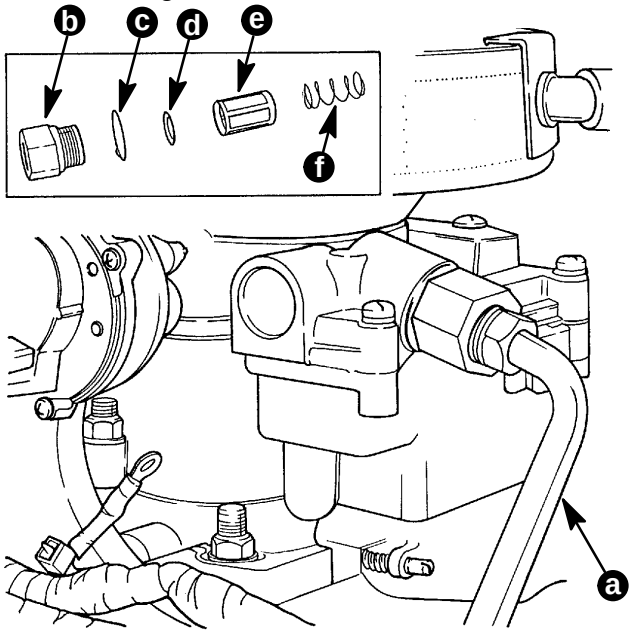
72086

a - Nut
b - Sealing Washer
c - Carburetor
d - Cable Tie
e - Crankcase Ventilvation Hose
f - Flame Arrestor

Fuel Inlet Filter

NOTICE
Refer to "Precautions," in this section, BEFORE proceeding.

1. Remove in the following order:
   a. Fuel line from fuel inlet filter nut.
   b. Fuel inlet filter nut and small gasket.
   c. Large gasket.
   d. Filter.
   e. Spring.
   f. Small gasket - from inside filter nut.



72406

a - Fuel Line
b - Fuel Inlet Filter Nut
c - Gasket (Larger)
d - Gasket (Small)
e - FIlter
f - Spring

2. Clean filter nut and spring in solvent and dry with compressed air.
3. Install in the following order:
   a. Spring - place in carburetor body.
   b. Filter - open end to inlet filter nut.
   c. Small gasket - place inside filter nut.
   d. Large gasket - place over filter nut threads.
   e. Fuel inlet filter nut - torque nut to 18 lb. ft. (24 N·m).
   f. Fuel line - torque to 18 lb. f N·m).

Index

Choke Inspection

The choke does not require any periodic maintenance; however, if a choke malfunction is suspected, the following should be done:

1. With engine turned OFF, remove flame arrestor.
2. Open and close choke several times, and check for binding, loose or disconnected linkages, or other signs of damage.
3. If choke or linkage binds, sticks, or works sluggishly, clean with carburetor choke cleaner. Follow directions on can.

IMPORTANT: Choke valve and shaft and lever assembly is not serviceable. If valve and/or shaft and lever assembly is worn or damaged, air horn assembly must be replaced.

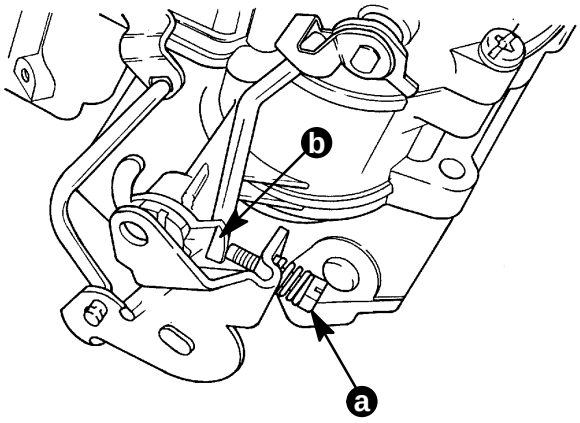
Adjustments

NOTICE

Refer to "Precautions," in this section, BEFORE proceeding.

Pump Rod

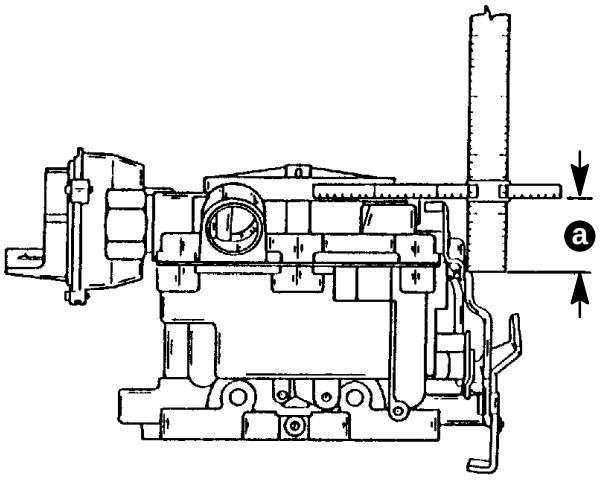
1. Back out idle speed screw until it no longer contacts idle cam.



72284

a - Idle Speed Screw
b - Idle Cam

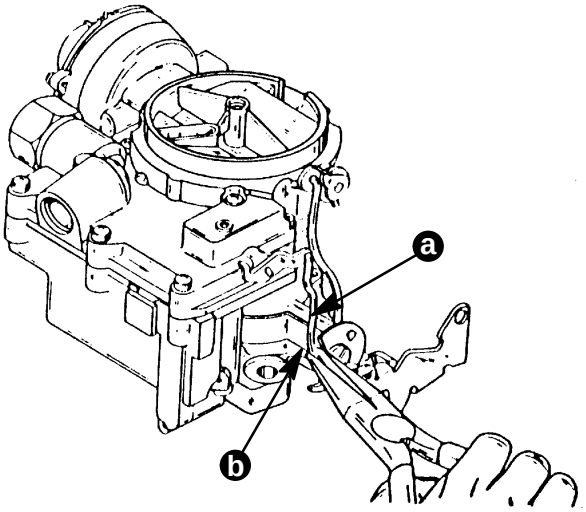
2. With throttle valves completely closed, measure from flame arrestor mounting surface to top of pump rod.



72682

a - See Specifications

3. Carefully bend pump rod (where shown) to obtain specified dimension.

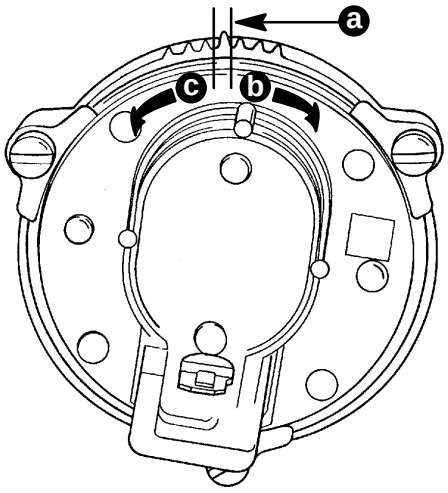


72683

a - Pump Rod
b - Bend Here

Choke Setting

Normal choke setting is such that scribed mark on cover is in line with long case mark on choke housing.



72403

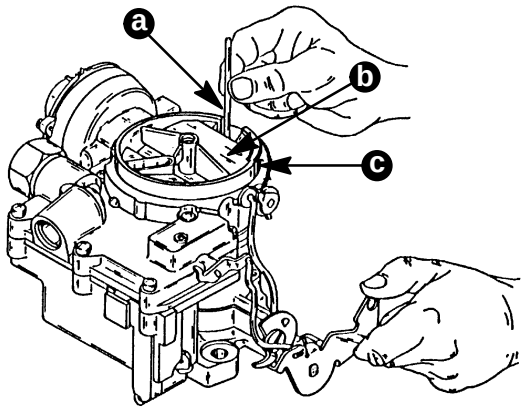
a - Scribed Mark
b - More Choke
c - Less Choke

If choke adjustment is necessary:

1. Loosen three choke cover retaining screws and adjust as shown.
2. Tighten three choke cover retaining screws securely.

Choke Unloader

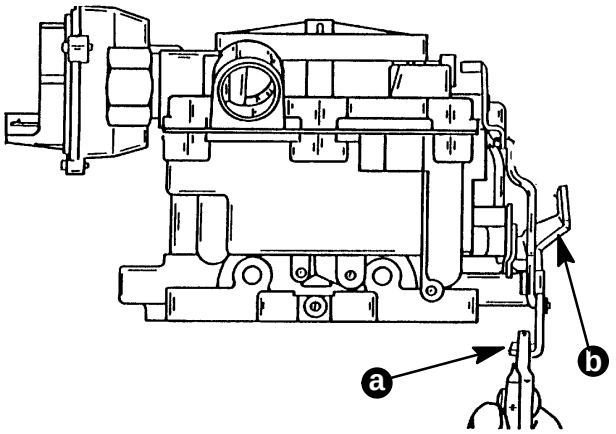
1. Hold throttle valves completely open.
2. Gently press down on choke plate.
3. Using an .080 in. [5/64 in.] (0.2 mm) drill rod, or appropriate gauge, slide rod between upper edge of choke plate and air horn assembly. Rod should just slide through.



72684

a - .080 In. (0.2mm) Drill Rod
b - Choke Plate
c - Air Horn

4. Bend tang on throttle lever, if necessary, to obtain specified dimension.



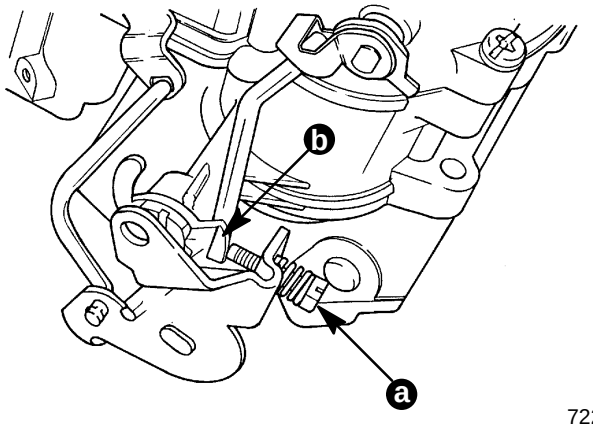
72685

a - Tang
b - Throttle Lever

Preliminary Idle Speed and Mixture

IMPORTANT: The following adjustments will provide a sufficient idle speed and mixture for starting engine. Final adjustments must be made with engine running.

1. Back out idle speed screw until it no longer contacts idle cam. Turn idle speed screw in until it just contacts idle cam, then turn screw in an additional two turns.



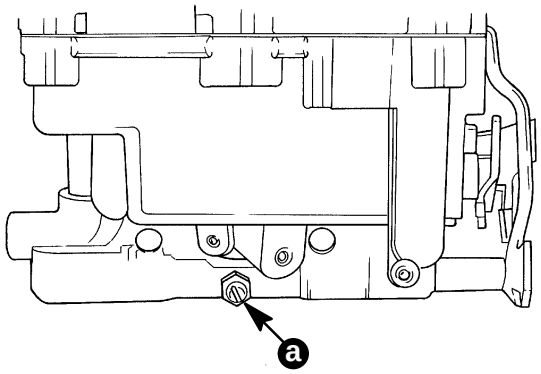
72284

a - Idle Speed Screw
b - Idle Cam

IMPORTANT: DO NOT turn idle mixture needle tightly against seat (in the following step), as damage to seat and/or needle may result.

Index

2. Turn idle mixture needle in until lightly seated, then back needle out 1-1/4 turns.



72281

a - Idle Mixture Needle

Final Idle Speed and Mixture

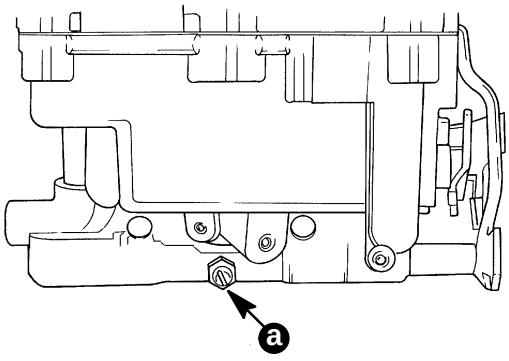
IMPORTANT: Boat must be in the water and engine at normal operating temperature to accurately check and adjust idle speed and mixture.

Carburetor should be set so that engine idles smoothly within range given under “Specifications,” with boat in the water, engine at normal operating temperature and drive unit in forward gear. To adjust idle speed and mixture, proceed as follows:

IMPORTANT: DO NOT attempt to compensate for other engine problems (incorrect ignition timing, faulty ignition components, low compression, vacuum leaks, etc.) with carburetor adjustments. This will only cover the problem, which must be corrected if engine is to achieve maximum fuel economy and performance.

1. Connect an accurate shop tachometer to engine.

IMPORTANT: DO NOT turn idle mixture needle tightly into seat, as damage to needle and/or seat may result.



72281

a - Idle Mixture Needle

2. If new or rebuilt carburetor has been installed, turn idle mixture needle in (clockwise) until it lightly contacts seat, then back out needle 1-1/4 turns. This will provide a sufficient setting to allow starting engine.
3. Start engine and run at 1500 RPM until engine reaches normal operating temperature.

⚠ WARNING

DO NOT leave the helm unattended while performing idle speed and mixture adjustments, following. BE CAREFUL NOT TO ACCIDENTALLY ACCELERATE ENGINE WHILE PERFORMING ADJUSTMENTS.

4. With boat in open water, place remote control in forward gear, idle position.
5. Disconnect throttle cable barrel from anchor stud. Be sure not to lose spacer on anchor stud.
6. Adjust idle speed adjustment screw to obtain 550-600 RPM, in neutral gear.
7. With engine running at specified RPM, adjust idle mixture needle as follows:
   a. Turn idle mixture needle in (clockwise) until the engine speed begins to drop due to lean mixture.
   b. Turn idle mixture screw out (counterclockwise) until the speed begins to drop due to rich mixture.
   c. Turn screw in to a point between these two extremes to obtain maximum engine smoothness and RPM.
   d. Readjust idle speed adjustment screw until engine idles at 650-700 RPM in forward gear.

IMPORTANT: Refer to Section 2 - “Removal and Installation” for throttle cable installation and adjustment.

Repair

NOTICE

Refer to “Precautions,” in this section, BEFORE proceeding.

Removal

IMPORTANT: Carburetor malfunctions are, in many cases, caused by the presence of dirt, water or other foreign matter in carburetor. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may then be inspected for contamination as carburetor is disassembled.

1. Remove ventilation hose from flame arrestor, then remove flame arrestor.

IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and foreign material from falling into bores.

2. Turn fuel supply off at fuel tank.
3. Disconnect throttle cable from carburetor.
4. Remove fuel line from fuel inlet nut, using wrench to stabilize fuel inlet nut.
5. Remove fuel pump sight tube from carburetor.
6. Disconnect electric choke.
7. Remove carburetor attaching nuts and washers and remove carburetor.

IMPORTANT: Place a clean cloth over intake manifold opening to prevent dirt or foreign material from entering manifold.

8. Remove and discard gaskets.

Installation

1. Thoroughly clean gasket surfaces.
2. Place new carburetor base gasket on intake manifold. Install carburetor and secure with nuts and washers. Torque to 132 lb. in. (15 N·m).
3. If fuel inlet filter nut was disturbed, remove; clean all threads with brush and carburetor cleaner or Quicksilver Leveler.
4. Connect fuel line to fuel inlet filter nut, and while stabilizing filter nut with wrench, tighten fuel line fitting securely.
5. Connect fuel pump sight tube to fitting on carburetor.
6. Connect electric choke wires to choke cover.
7. Install throttle cable as explained in Section 2.
8. Install flame arrestor and crankcase ventilation hose.
9. Reconnect battery cables to battery.
10. Ensure that water is supplied to cooling system. Start engine and check for gasoline leaks. If leaks exist, STOP ENGINE IMMEDIATELY and recheck connections.
11. Adjust idle speed and idle mixture, as outlined under “Adjustments” as previously outlined.

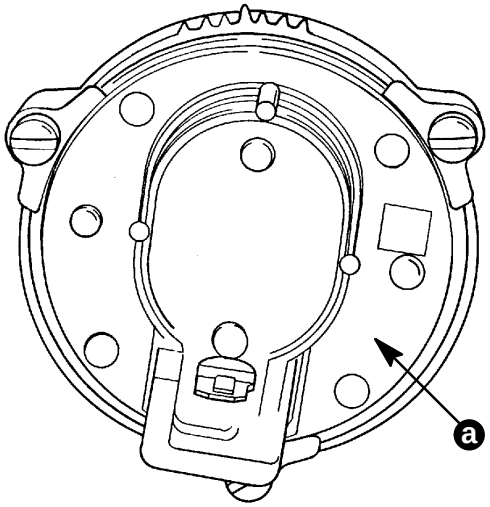
Disassembly

IMPORTANT: Before performing any service on carburetor, it is essential that carburetor be placed in a holding fixture to prevent possible damage to throttle valves.

The following is a step-by-step procedure for completely overhauling carburetor removed from engine. In many cases, however, complete overhaul is not necessary and, in these cases, only the steps required to repair the carburetor malfunction should be performed. Read the instructions carefully to prevent doing any unnecessary steps.

CHOKE HOUSING ASSEMBLY

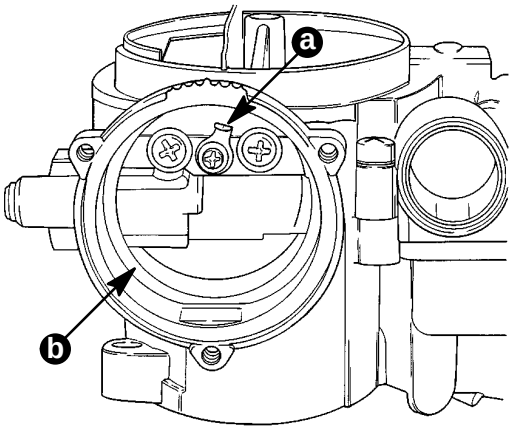
1. Remove choke cover.



72403

a - Choke Cover

2. Remove choke lever. Remove choke housing.

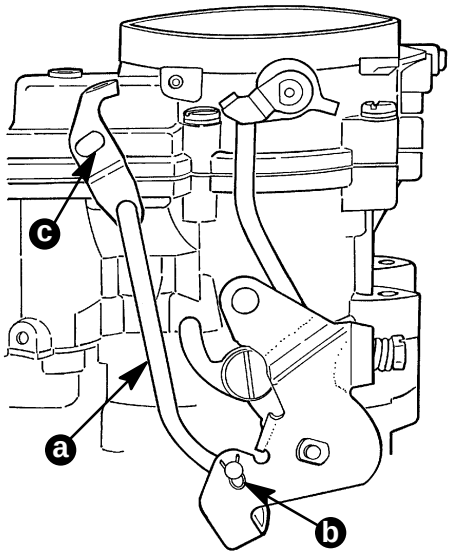


72401

a - Choke Lever
b - Choke Housing

AIR HORN ASSEMBLY

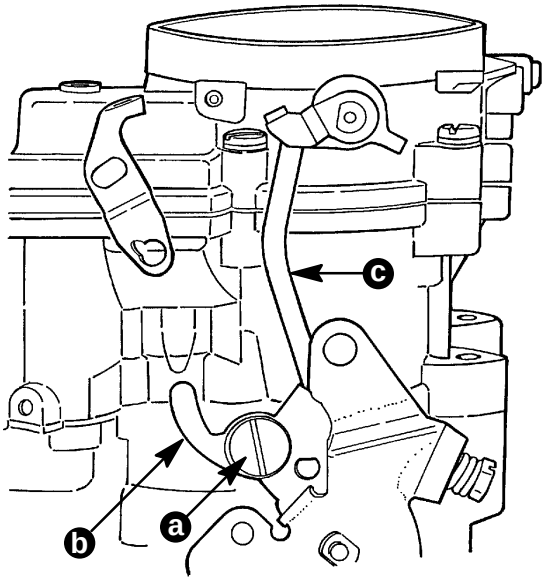
1. Remove fuel inlet filter nut, washers, spring, and filter, as outlined previously.
2. Remove accelerator pump rod retaining clip. Pivot rod (as required) until retaining ear on rod and slot in pump shaft and lever assembly align, allowing rod to be pulled out.



72283

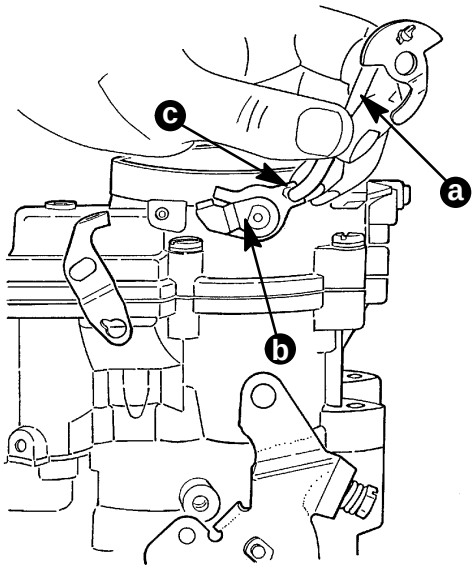
a - Accelerator Pump Rod
b - Retainer Clip
c - Pump Shaft and Lever Assembly

3. Remove idle cam screw. Also, remove choke rod by pivoting rod (as required) until retaining ear on rod and slot in choke lever align, allowing rod to be pulled out.



72282

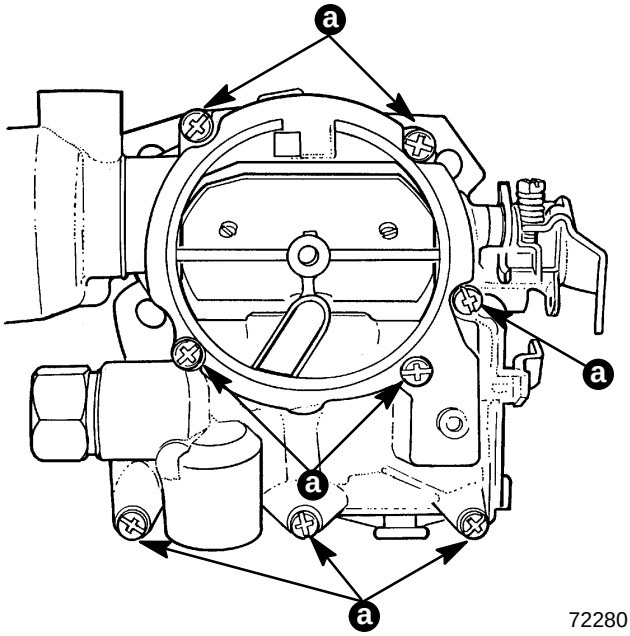
a - Idle Cam Screw
b - Idle Cam
c - Choke Rod



72286

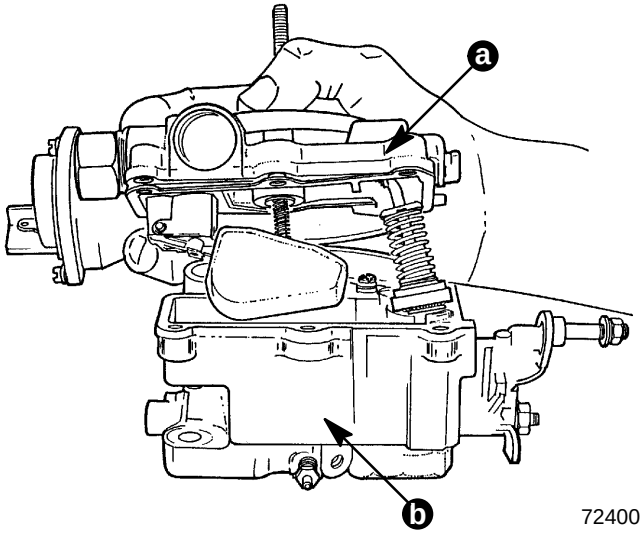
a - Choke Rod
b - Choke Lever
c - Slot

4. Remove air horn attaching screws as shown. Carefully lift air horn from float bowl assembly.



72280

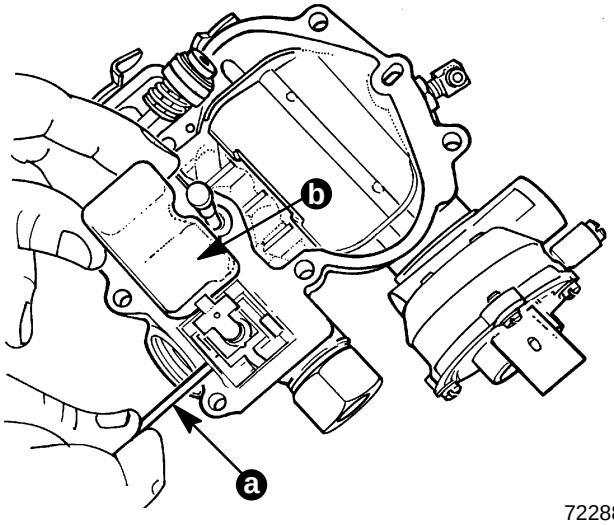
a - Air Horn Attaching Screws



72400

a - Air Horn Assembly
b - Float Bowl Assembly

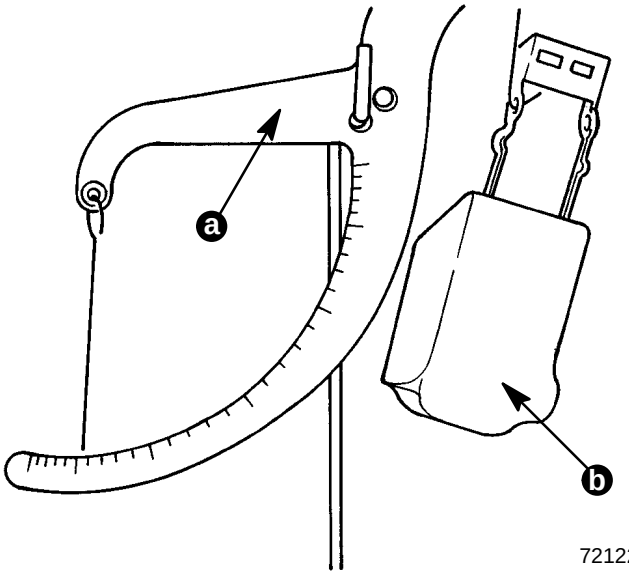
5. Invert air horn and carefully lay on bench.
6. Remove float hinge pin and lift float assembly from air horn.



72288

a - Float Hinge Pin
b - Float Assembly

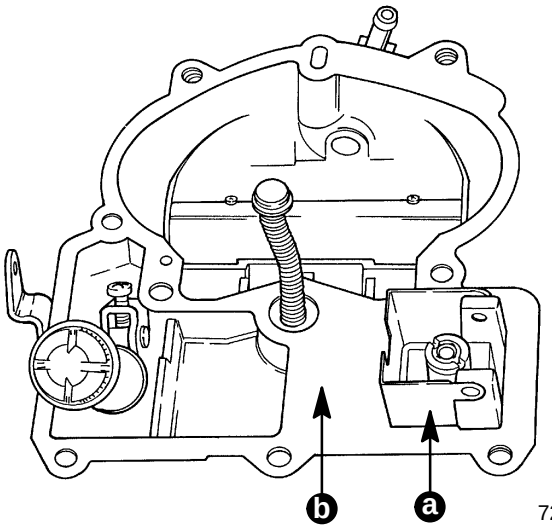
7. Check float weight as shown.



72122

a - Grams Scale
b - Float

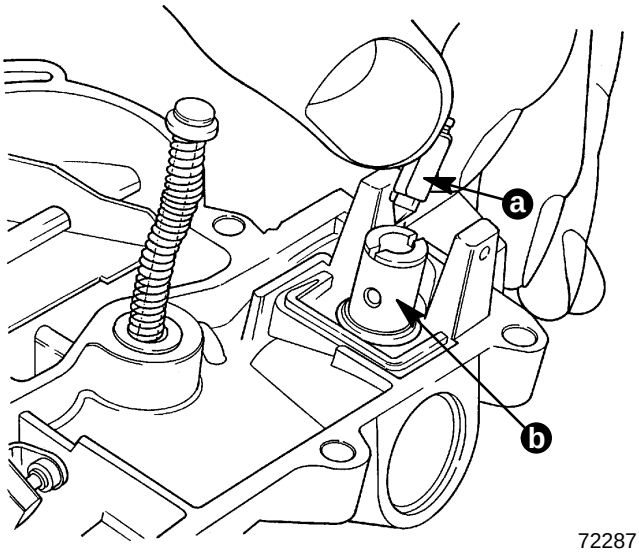
8. Remove air horn gasket and baffle.



72399

a - Baffle
b - Air Horn Gasket

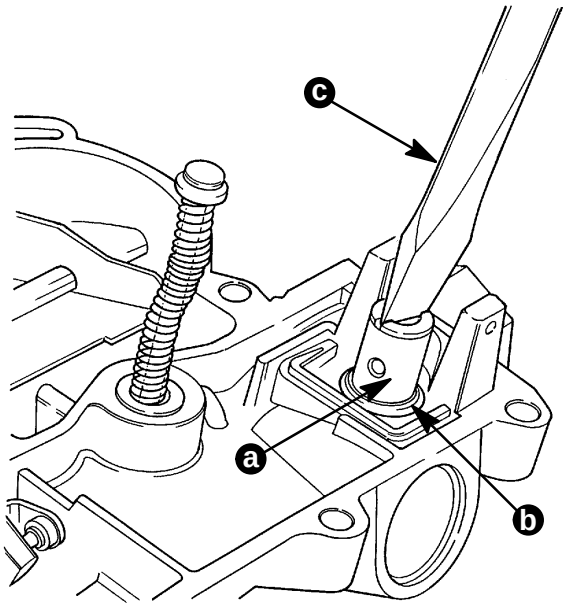
9. Remove needle assembly.



72287

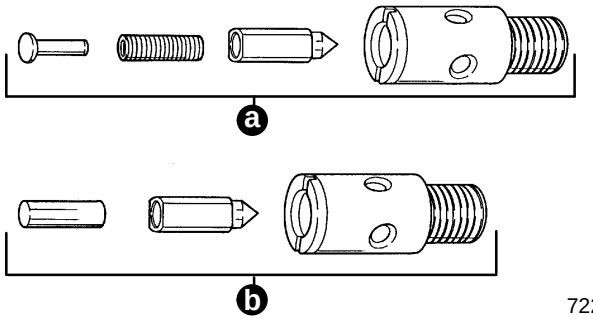
a - Needle Assembly
b - Needle Seat

10. Remove needle seat.



72289

a - Needle Seat
b - Gasket
c - Screwdriver

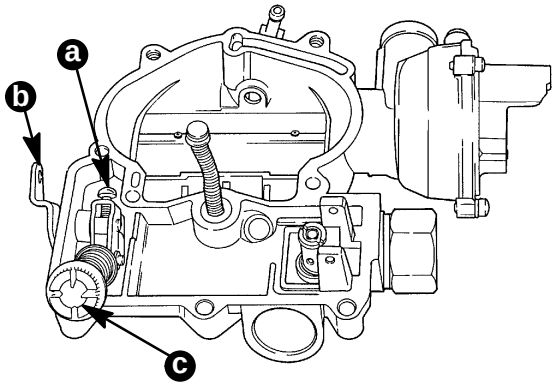


72290

Needle and Seat Assemblies

a - Spring Loaded Type Needle (Kit 3302-9029)
b - Solid Type Needle (Kit 3302-9407)

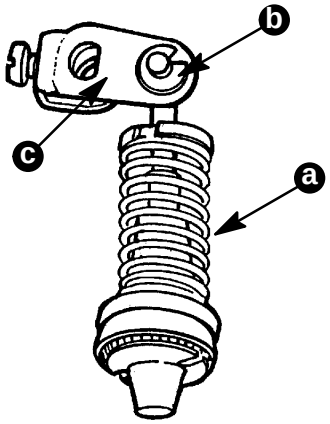
11. Loosen accelerator pump screw. Slide pump shaft and lever assembly (and washer) out of air horn, then remove accelerator pump assembly.



72398

a - Set Screw
b - Lever Assembly
c - Pump Assembly

12. Remove retainer clip and washer from pump shaft and lever assembly, then remove accelerator pump assembly.

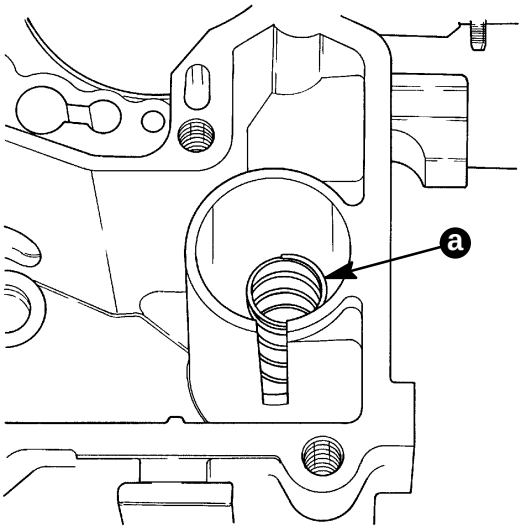


72409

a - Pump Assembly
b - Retainer Clip
c - Lever Assembly

FLOAT BOWL ASSEMBLY

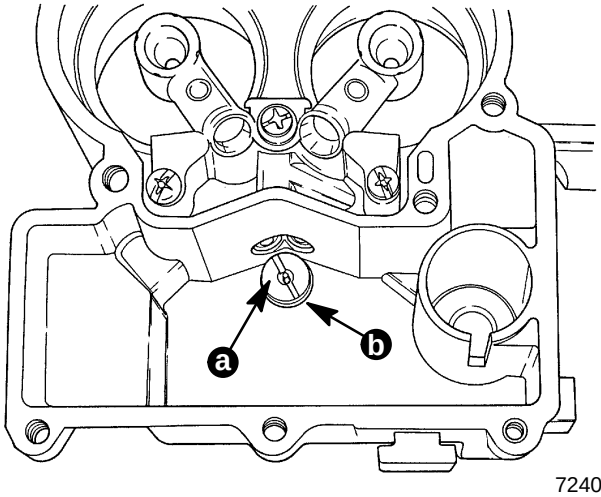
1. Remove accelerator pump return spring from pump well.



72402

a - Accelerator Pump Spring

2. Remove power valve assembly and gasket.

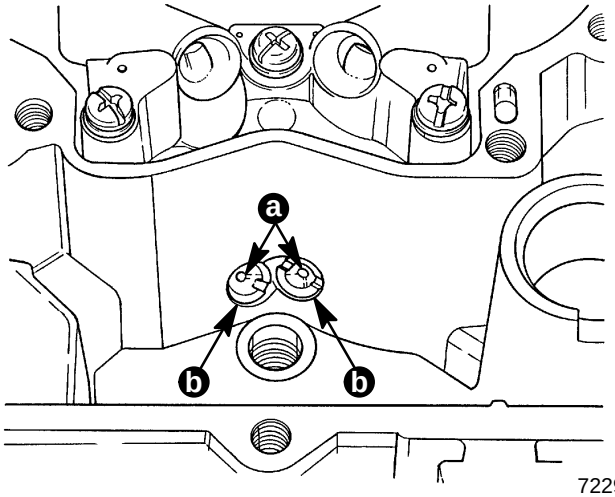


72404

a - Power Valve Assembly
b - Gasket (Not Shown)

Index

3. Remove main metering jets.

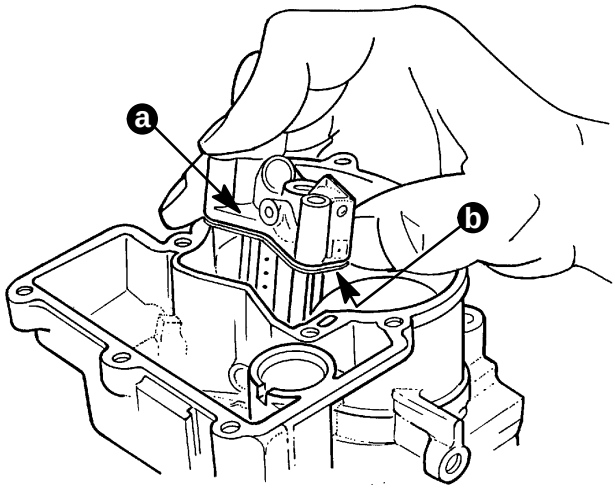


72291

a - Main Metering Jets
b - Gaskets (Not Shown)

IMPORTANT: Use care when removing venturi cluster to prevent damaging brass tubes which protrude from bottom of cluster. DO NOT REMOVE TUBES. These tubes are permanently pressed into the venturi cluster and are not replaceable.

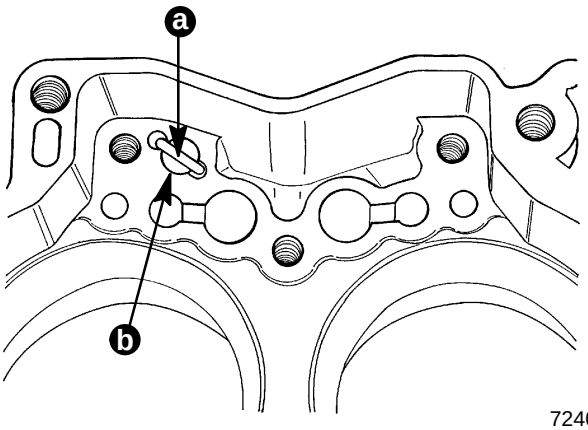
4. Remove three venturi cluster screws, and carefully lift cluster and venturi gasket straight up.



72292

a - Venturi Cluster Brass Tubes
b - Gasket

5. Using a needle-nose pliers, remove accelerator pump check ball spring retainer. Turn float bowl over to remove spring and check ball.



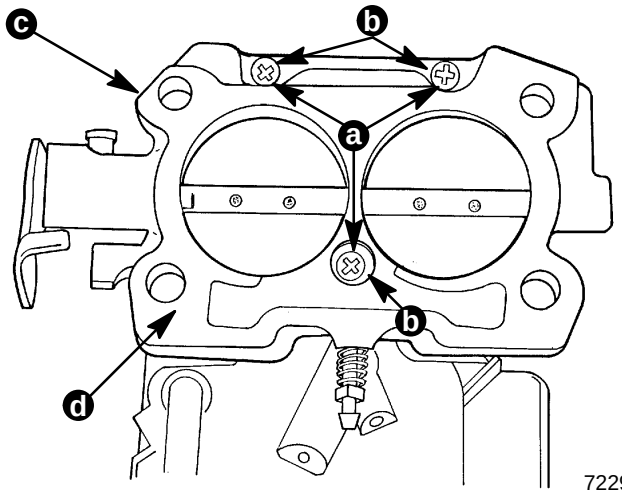
72407

a - Spring Retainer
b - Spring and Check Ball (Not Shown)

THROTTLE BODY ASSEMBLY

IMPORTANT: Use extreme care when handling throttle body, so as not to damage throttle valves.

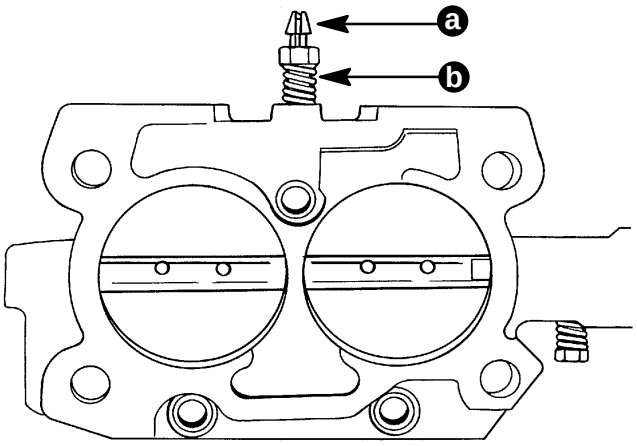
1. Place float bowl assembly upside down. Remove three throttle body assembly attaching screws and lockwashers, and remove throttle body and gasket from float bowl.



72294

a - Screws
b - Lockwashers (Not Shown)
c - Throttle Body
d - Gasket (Not Shown)

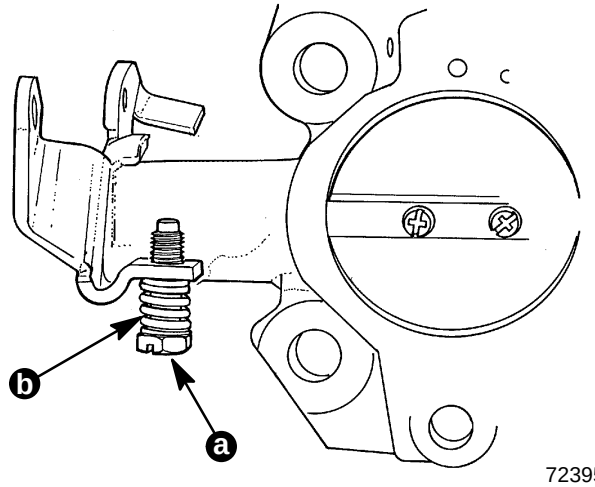
2. Remove idle mixture adjusting needle and spring.



72293

a - Idle Mixture Adjusting Needle
b - Spring

3. Remove idle speed adjustment screw and spring, if replacement is necessary.



72395

a - Idle Speed Screw
b - Spring

IMPORTANT: DO NOT remove throttle valves. If any of the throttle body parts are found to be worn or damaged, complete throttle body assembly MUST BE replaced. Throttle body assembly can be cleaned in carburetor cleaner.

Cleaning and Inspection

IMPORTANT: DO NOT use a wire or drill to clean jet passages or tubes in carburetor, as this may enlarge orifices and seriously affect carburetor calibration.

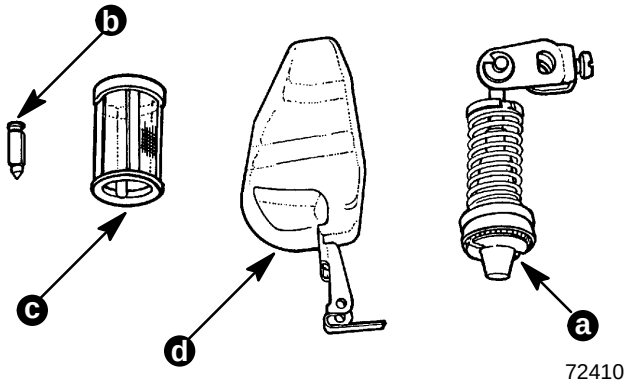
⚠CAUTION

To avoid damage to carburetor DO NOT leave carburetor in immersion type carburetor cleaner for more than two hours.

IMPORTANT: DO NOT clean float bowl gasket surfaces with a gasket scraper or knife, as sealing bead will be damaged and float bowl replacement will be necessary.

⚠CAUTION

The float assembly, float needle, accelerator pump plunger, and fuel filter MUST NOT BE immersed in carburetor cleaner, as they will swell, harden, and/or distort.



72410

a - Accelerator Pump Plunger
b - Float Needle
c - Fuel Filter
d - Float Assembly

⚠WARNING

Avoid personal injury by always wearing safety goggles when using compressed air.

1. Thoroughly clean all metal parts in a commercial carburetor cleaner, until all deposits have been removed. Follow cleaner manufacturer's instructions for proper cleaning and rinsing procedure. Dry parts with compressed air.
2. Using compressed air, blow out all passages in carburetor to remove any foreign material.
3. Wipe off all parts that cannot be cleaned in carburetor cleaner with a clean, dry cloth.
4. Carefully inspect all carburetor parts for wear and damage; pay particular attention to the following:

   a. **Float Needle and Seat**: If float needle or seat is worn or damaged, replace with new needle and seat assembly.

IMPORTANT: Float needle and seat are factory matched and tested and should be replaced as a set only.

   b. **Float Assembly and Hinge Pin:** Check float density (to see if it is saturated with fuel) by comparing weight of float with specifications. If weight is high, float assembly must be replaced. Check hinge pin and holes for wear.

   c. **Fuel and Air Passages:** Passages must be perfectly clean for proper carburetor operation.

   d. **Accelerator Pump Plunger and Return Spring:** Inspect pump plunger cup, pump plunger spring (on pump assembly) and return spring.

   e. **Power Piston Spring:** Check power piston spring for weakness or distortion.

   f. **Idle Mixture Needle:** Inspect idle mixture needle. If damaged, needle must be replaced.

   g. **Levers and Linkages:** Check levers, links and rods for wear.

   h. **Throttle Valve and Shaft:** Check throttle shaft for excessive looseness in throttle body. Check throttle valve and shaft for binding through entire operating range, making sure valve opens and closes completely. Throttle body assembly must be replaced if throttle valve and shaft are worn or damaged.

   i. **Choke Valve and Shaft and Lever Assembly:** Check shaft and lever assembly for excessive looseness in air horn assembly. Check choke valve and shaft and lever assembly for binding through entire operating range, making sure valve opens and closes completely. Air horn assembly must be replaced if choke valve and shaft and lever assembly are worn or damaged.

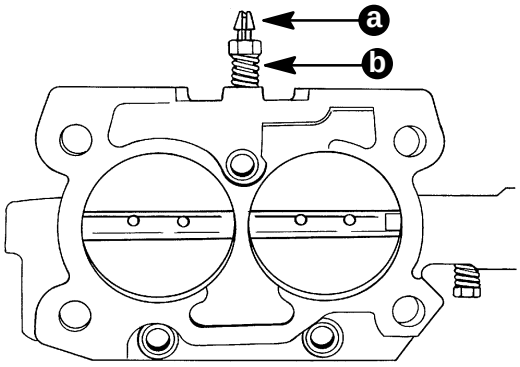
   j. **Inspect Casting** for visible damage. Inspect gasket surfaces. Inspect accelerator pump plunger well for scoring or deposits.

Reassembly

THROTTLE BODY ASSEMBLY

IMPORTANT: DO NOT force idle mixture needle against seat as damage to needle and/or seat will result.

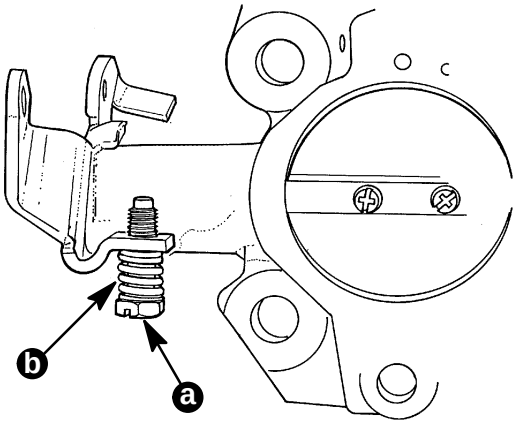
1. Screw idle mixture needle (and spring) into throttle body until they lightly seat, then back out needle 1-1/4 turns as a preliminary idle mixture setting. Final adjustment will be made with engine running. Refer to "Adjustments."



72293

a - Idle Mixing Adjusting Needle
b - Spring

2. Thread idle speed adjustment screw and spring into throttle lever.

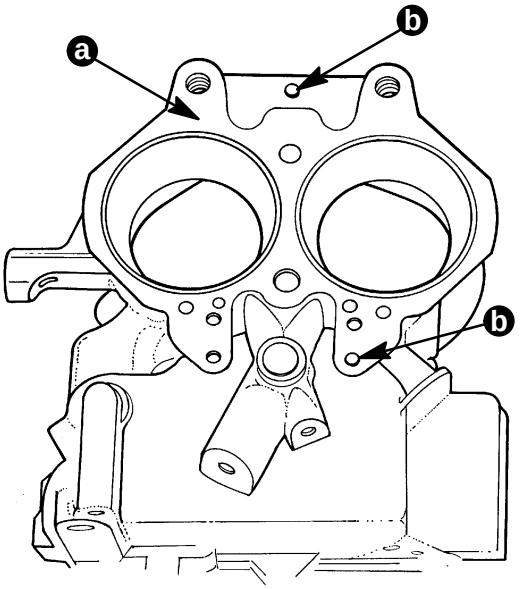


72395

a - Idle Speed Screw
b - Spring

Index

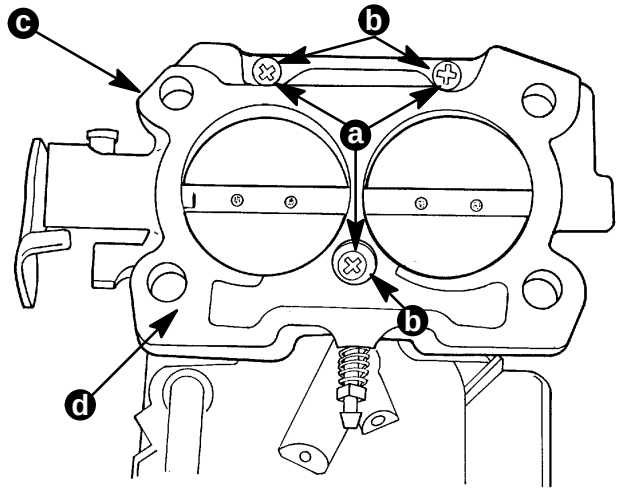
3. Turn float bowl assembly upside down and place new throttle body gasket on bowl, making sure gasket is properly positioned on location dowels.



72295

a - Throttle Body Gasket
b - Locating Dowels

4. Install throttle body assembly on float bowl assembly, making sure that screw holes in gasket line up with screw holes in throttle body. Tighten screws evenly and securely.



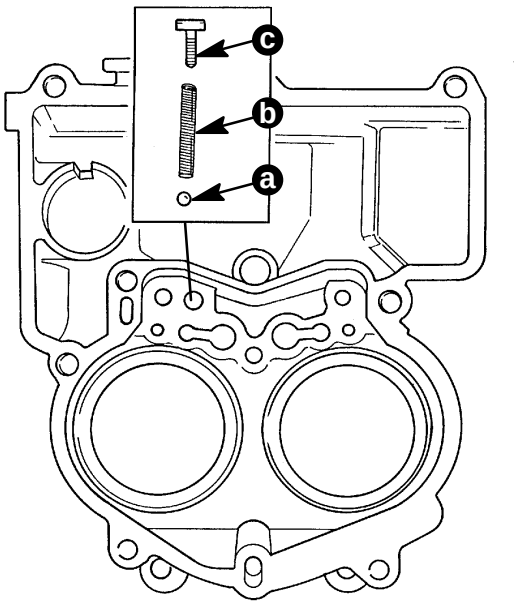
72294

a - Screws
b - Lockwashers (Not Shown)
c - Throttle Body Assembly
d - Gasket

FLOAT BOWL ASSEMBLY

IMPORTANT: Place float bowl and throttle assemblies in holding fixture to prevent throttle valves from being damaged.

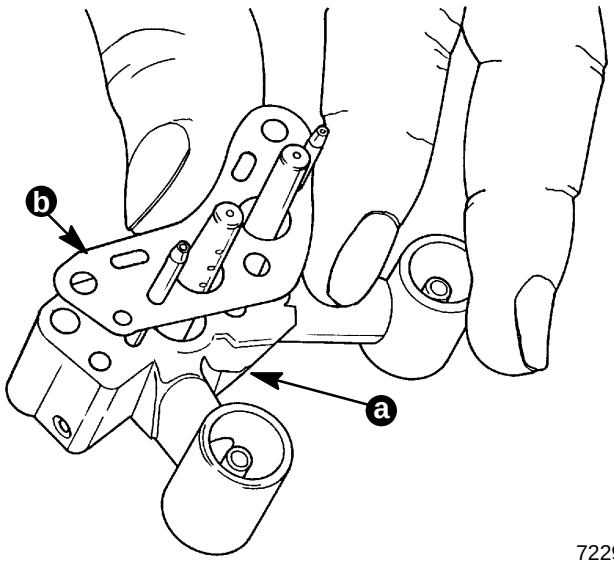
1. Install check ball, spring, and retainer in passage as shown. Push retainer firmly into slots.



72408

a - Check Ball
b - Spring
c - Retainer

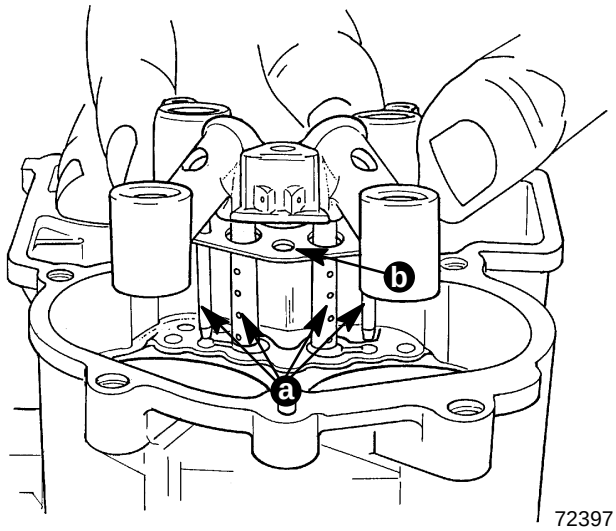
2. Install new gasket on venturi cluster as shown.



72296

a - Venturi Cluster (I.D. No. 421)
b - Gasket

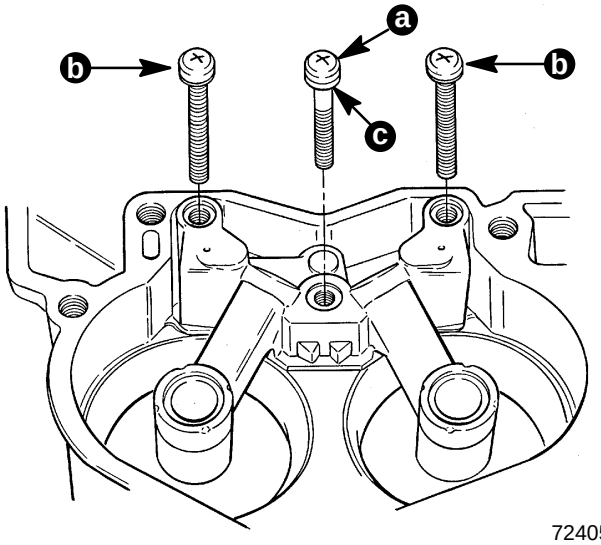
3. Install venturi cluster in carburetor as shown.



72397

a - Venturi Cluster
b - Gasket

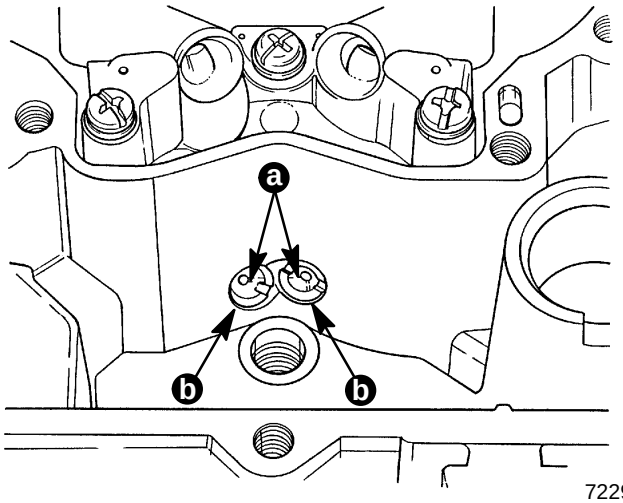
4. Install flat washer and new fiber washer on center screw. Lockwashers and flat washers are used on outer screws. Tighten screws evenly and securely.



72405

a - Center Screw
b - Outside Screws
c - Fiber Washer

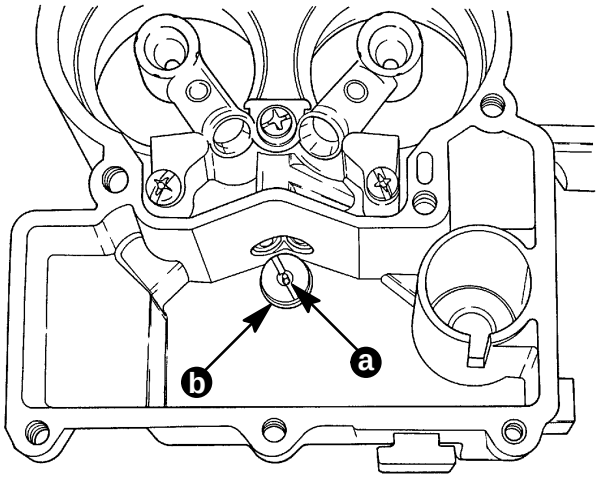
5. Install main metering jets with gaskets as shown. Tighten securely.



72291

a - Main Metering Jets
b - Gaskets (Not Shown)

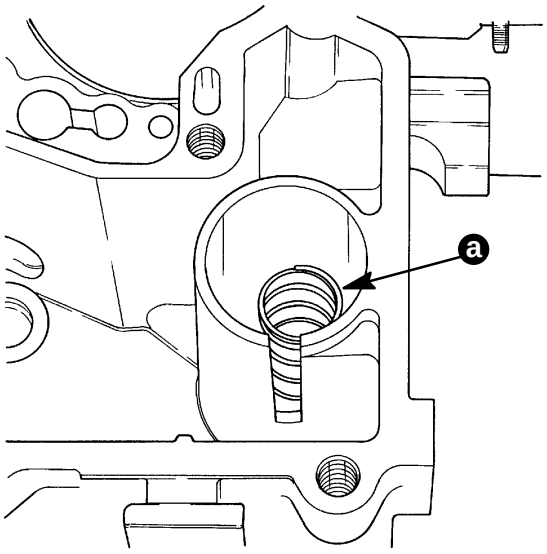
6. Install power valve with new gasket. Tighten securely.



72404

a - Power Valve
b - Gasket (Not Shown)

7. Place accelerator pump spring in pump well.



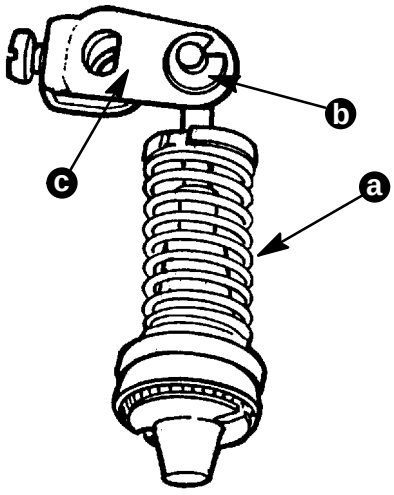
72402

a - Accelerator Pump Spring

AIR HORN ASSEMBLY

IMPORTANT: Accelerator pump assembly MUST BE installed correctly. If pump assembly is installed incorrectly, top of pump assembly will contact air horn casting.

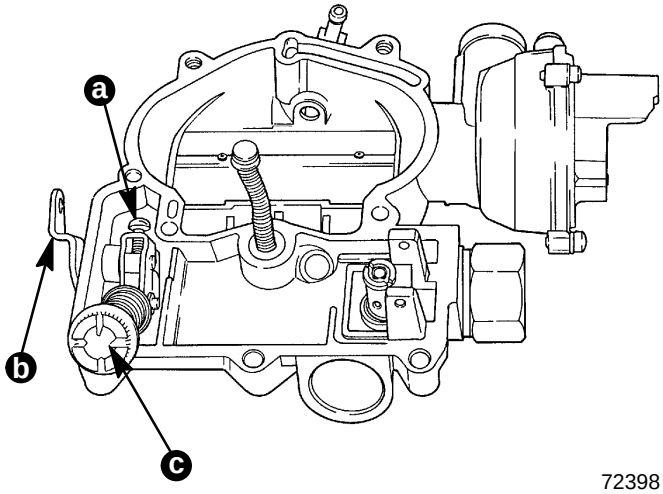
1. If accelerator pump assembly was removed from pump lever, secure pump assembly to pump lever with washer and retainer clip, as shown.



72409

a - Pump Assembly
b - Retainer Clip
c - Pump Lever

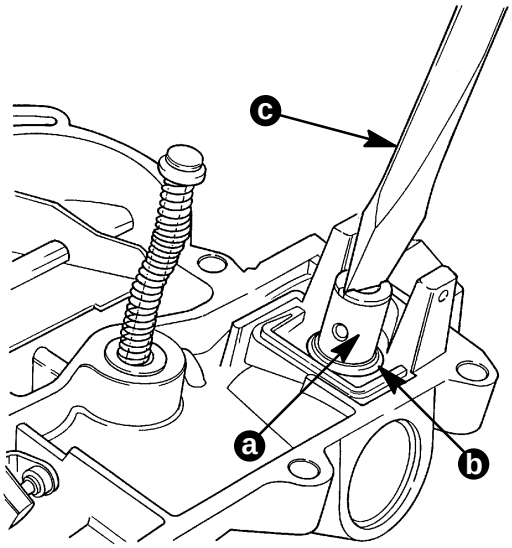
2. Insert pump shaft and lever assembly (and washer) into air horn; then, align indexed hole in pump lever with shaft and lever assembly and slide shaft all the way into lever so that shoulder on shaft is hitting lever. Tighten setscrew securely.



72398

a - Set Screw
b - Lever Assembly
c - Pump Assembly

3. Install needle seat and gasket. Tighten securely.

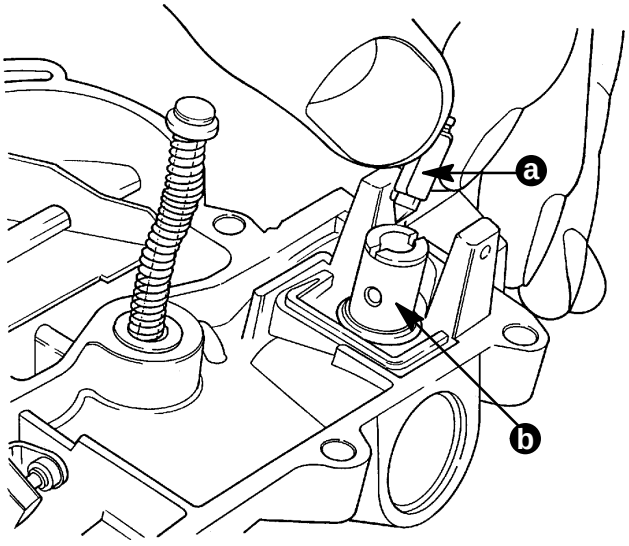


72289

a - Needle Seat
b - Gasket
c - Screwdriver

IMPORTANT: Float needle and needle seat are factory matched and tested and should be replaced as a set only.

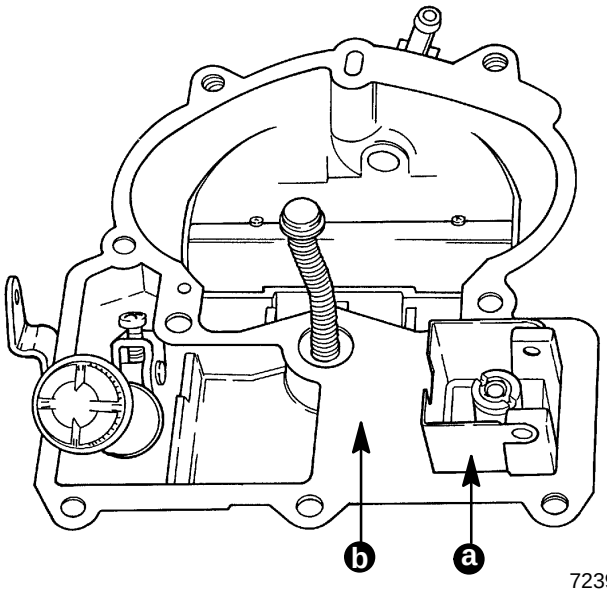
4. Place needle assembly in needle seat.



72287

a - Needle Assembly
b - Needle Seat

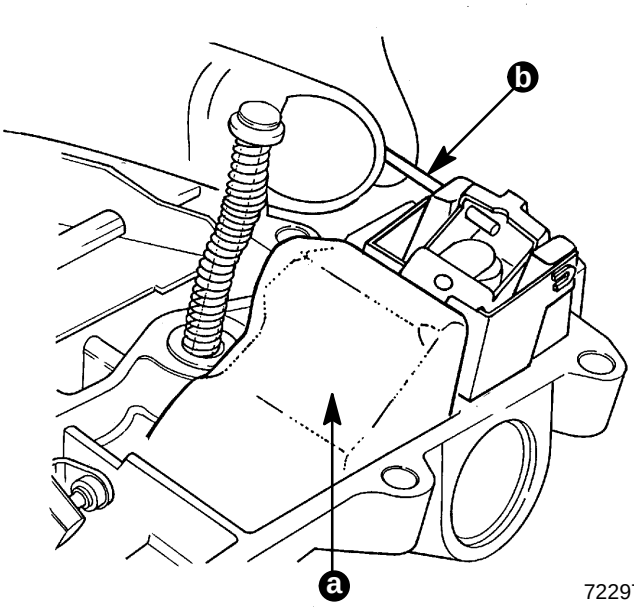
5. Install baffle and gasket.



72399

a - Baffle
b - Gasket

6. Install float assembly and hinge pin. Pivot float assembly up and down on hinge pin to ensure it moves freely.



72297

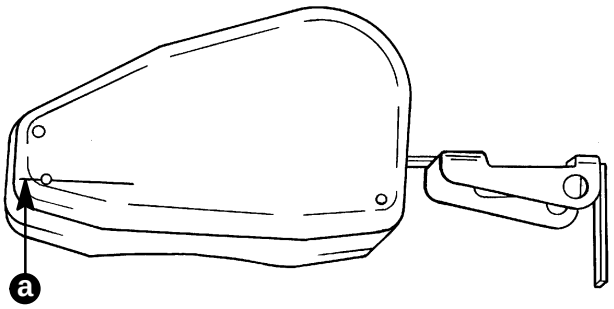
a - Float Assembly
b - Float Hinge Pin

FLOAT LEVEL

1. Turn air horn upside down. Pivot float assembly up and down on hinge pin to ensure it moves freely.

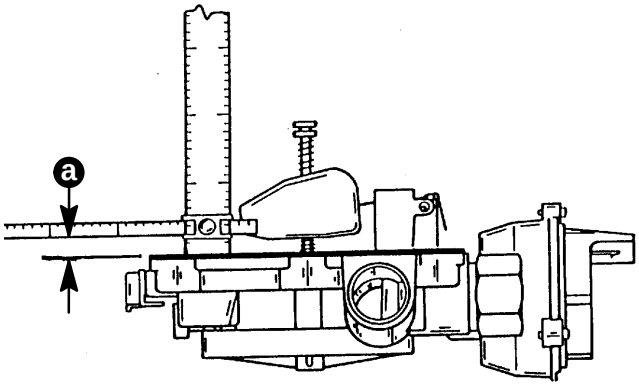
IMPORTANT: Before checking float level, raise float and allow it to fall; however, DO NOT force downward by hand.

2. Measure float level using Universal Carburetor Gauge (91-36392). Measure from gasket to toe of float.



72298

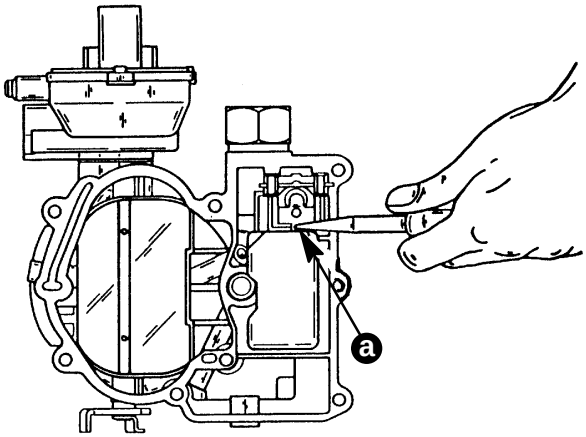
a - Measure From This Point to Gasket



72687

a - Measurement with 2 Piece Solid Inlet Needle - 3/8 in. (10mm)
Measurement with Spring Loaded Inlet Needle - 9/16 in (14mm)

3. Bend float arm up or down at point shown to obtain specified dimension.



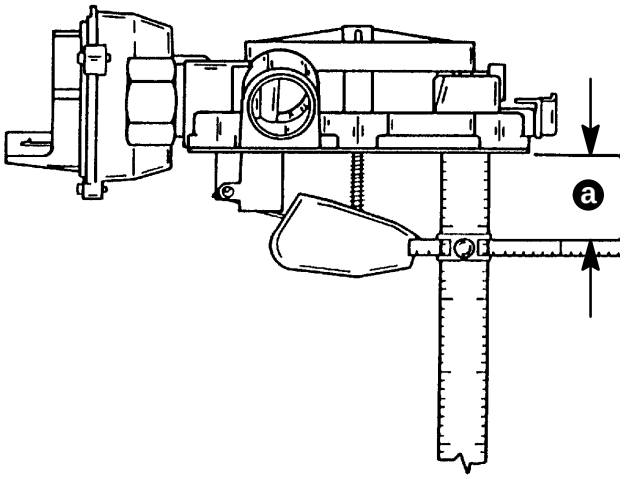
72688

a - Bend Float Arm at This Point

4. Visually check float alignment after adjustment.

FLOAT DROP

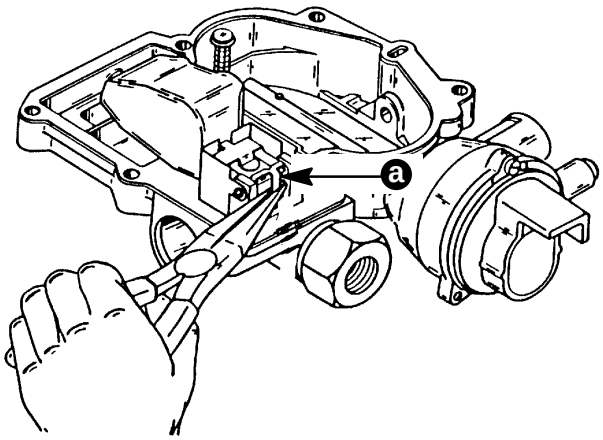
1. Hold air horn right side up to allow float to hang free.
2. Measure float drop using Universal Carburetor Gauge (91-36392). Measure from gasket to toe of float.



72689

a - Measurement - 1-3/32 in. (27mm)

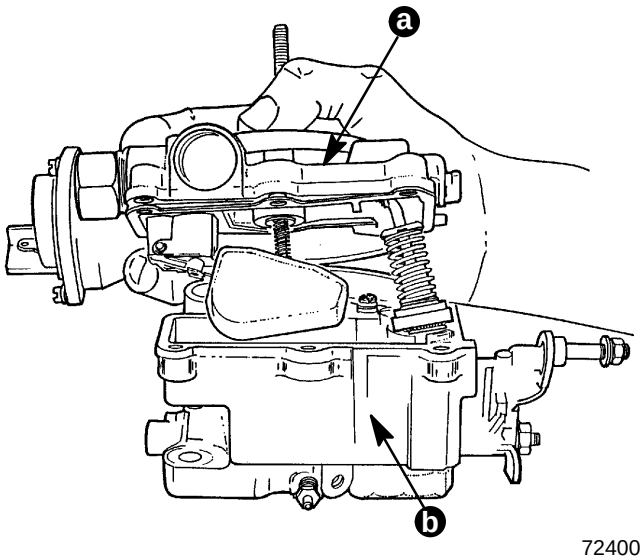
3. Bend float assembly tang, as shown, to obtain specified dimension.



72690

a - Float Assembly Tang

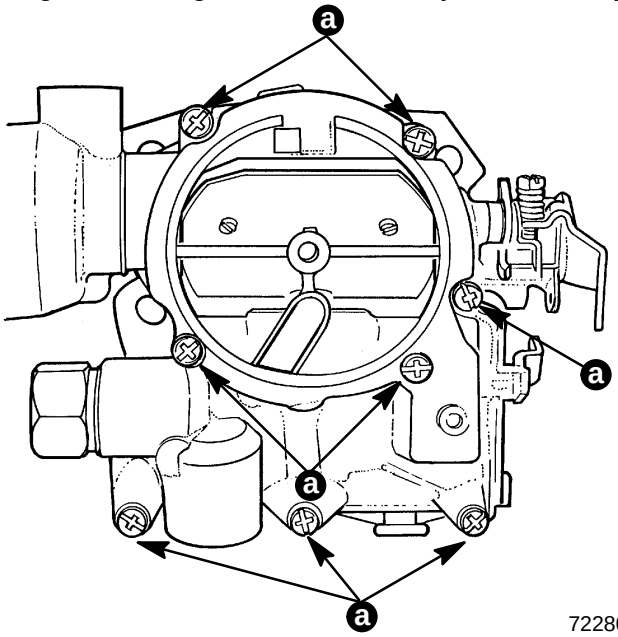
4. Recheck BOTH float level and float drop.
5. Carefully place air horn on float bowl, making sure accelerator pump is correctly positioned in fuel well. Lower air horn straight down to install.



72400

a - Air Horn Assembly
b - Float Bowl Assembly

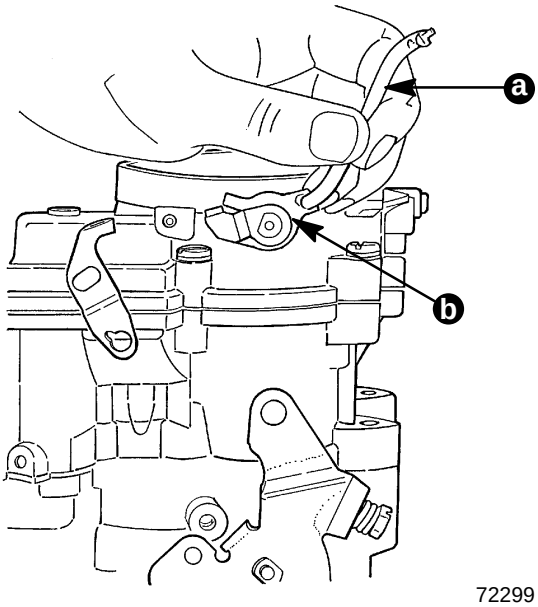
6. Install seven short and one long air horn attaching screws. Tighten screws evenly and securely.



72280

a - Air Horn Attaching Screws

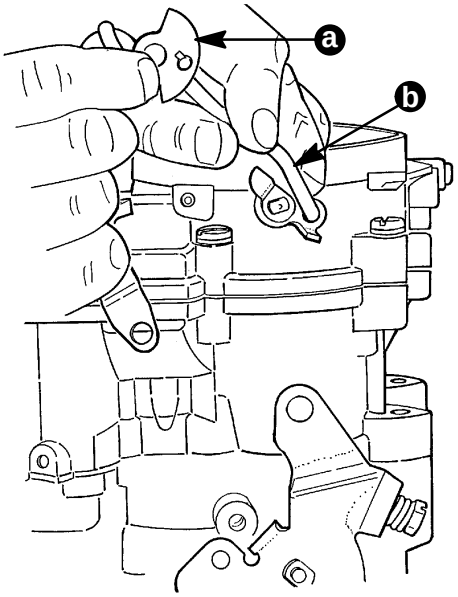
7. Place end of choke rod in choke lever and collar assembly.



72299

a - Choke Rod
b - Choke Lever and Collar Assembly

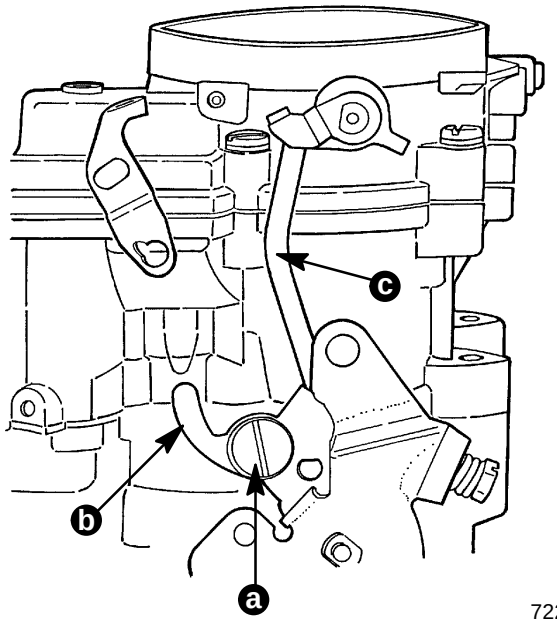
8. Place idle cam on choke rod.



72392

a - Idle Cam
b - Choke Rod

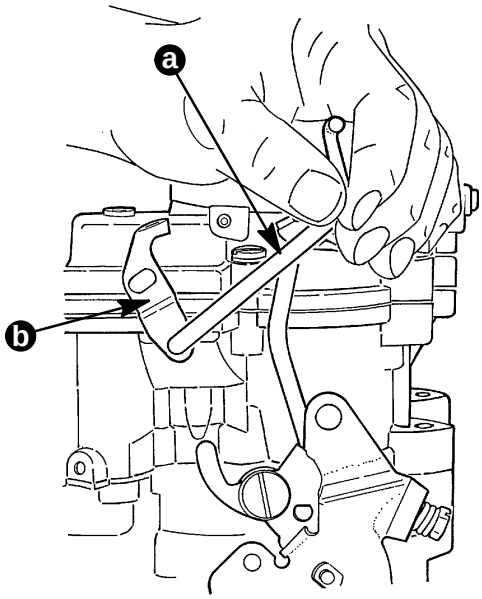
9. Secure idle cam (with choke rod installed on cam) on float bowl assembly, using screw. Check that cam is free to move without binding.



72282

a - Screw
b - Idle Cam
c - Choke Rod

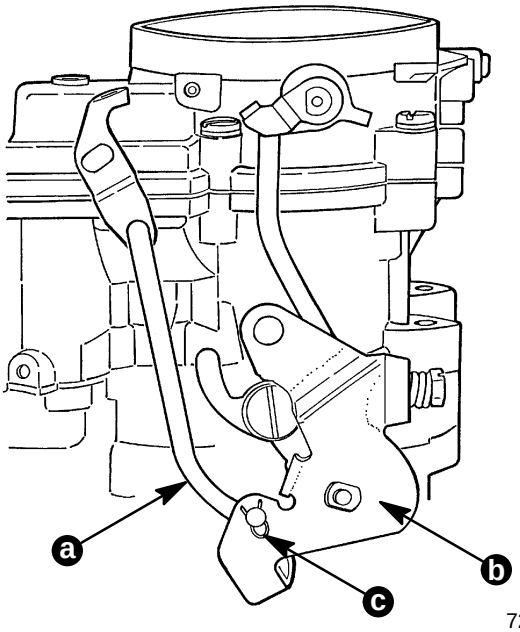
10. Place accelerator pump rod (end with ear) in hole in pump shaft and lever assembly.



72393

a - Accelerator Pump Rod
b - Pump Shaft and Lever Assembly

11. Insert remaining end of accelerator pump rod into hole in throttle lever and secure with retainer clip.

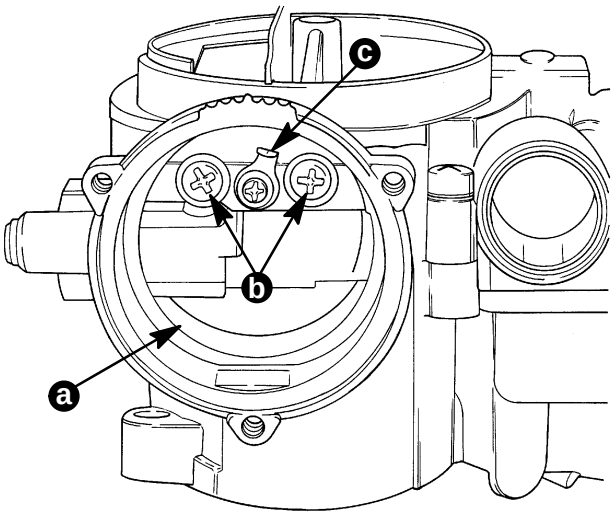


72283

a - Accelerator Pump Rod
b - Throttle Lever
c - Retainer Clip

CHOKE HOUSING ASSEMBLY

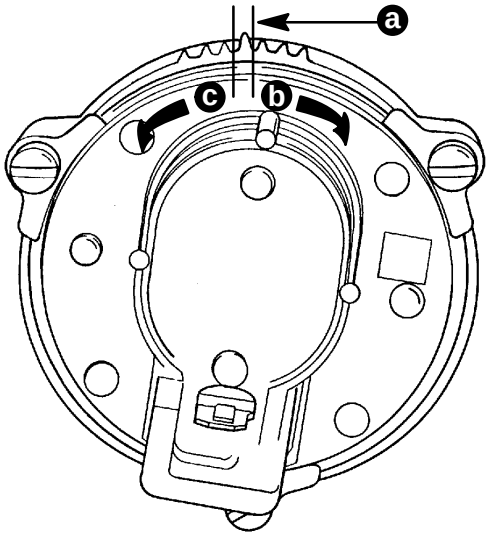
1. Install choke housing on air horn; tighten screws securely. Install choke lever; tighten screw secure-
ly.



72401

a - Choke Housing
b - Choke Housing Attaching Screws
c - Choke Lever

2. Install choke cover. Make sure hook on end of choke coil engages with choke lever. Rotate choke cover until index marks align as shown. Tighten screws securely.

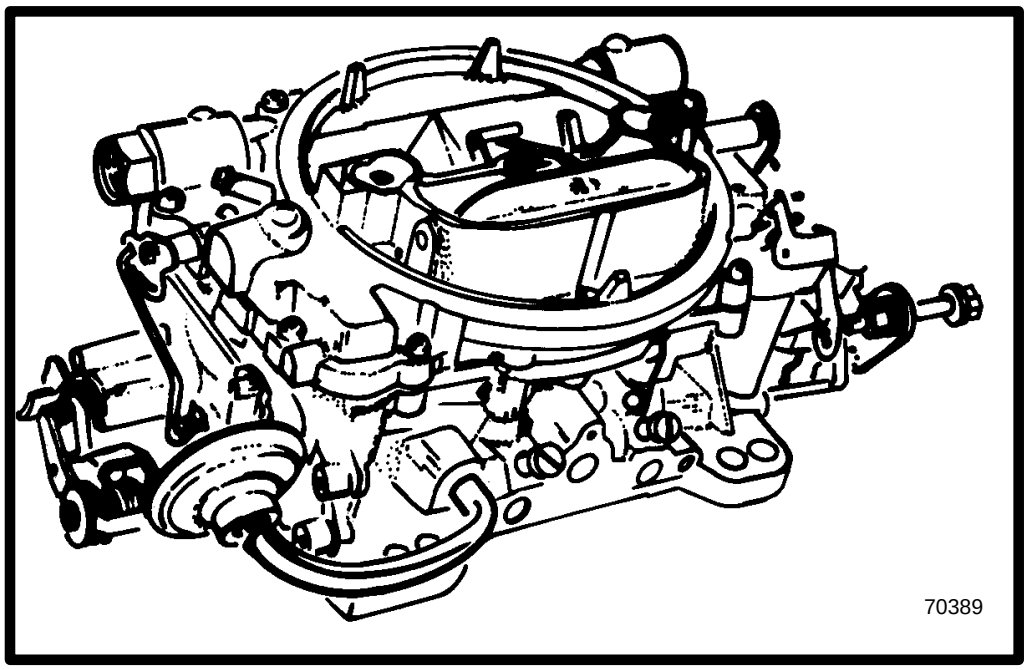


72403

a - Scribed Mark
b - More Choke
c - Less Choke

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

FUEL SYSTEMS



5

C

WEBER 4 BARREL CARBURETOR

Index

Table of Contents

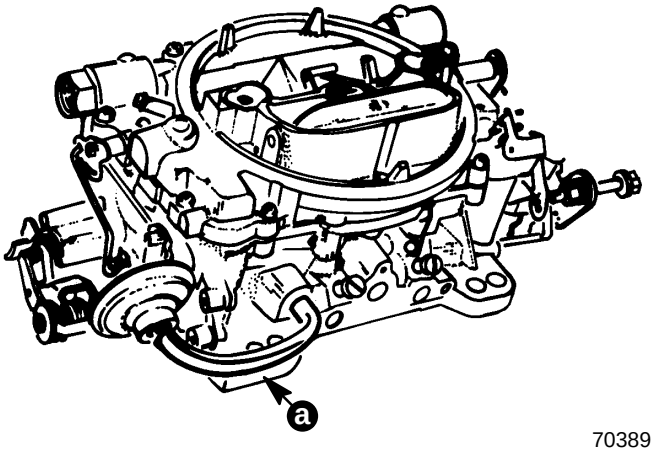
	Page
Identification	5C-1
Replacement Parts Warning	5C-1
Torque Specifications	5C-1
Tools	5C-1
Specifications	5C-2
Jet Changes for Altitude	5C-2
Carburetor Adjustment Specifications	5C-3
Description	5C-4
Precautions	5C-4
Important Service Information	5C-5
Weber Carburetor Adjustable Accelerator Pump	5C-5
Hard Starting	5C-5
Carburetor Metering Rod And Jet Identification	5C-6
Maintenance	5C-7
Flame Arrestor	5C-7
Fuel Filter	5C-8
Adjustments	5C-9
Accelerator Pump	5C-9
Choke Pull-Off	5C-10
Float Drop	5C-10
Float Level	5C-11
Idle Speed and Mixture Adjustments	5C-12
Thunderbolt IV Equipped Engines	5C-12
Thunderbolt V Equipped Engines	5C-14
Repair	5C-15
Removal	5C-15
Installation	5C-16
Exploded View	5C-18
Disassembly	5C-19
Cleaning and Inspection	5C-28
Reassembly	5C-29

NOTICE

For information and procedures on trouble-shooting, refer to Section 1C.

Index

Identification



70389

a - Weber Identification Number Location

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Torque Specifications

Fastener Location	in. lb.	lb. ft.	N·m
Carburetor To Manifold	132		15
Fuel Line To Carburetor		18	24

Tools

Description	Part Number
Universal Carburetor Gauge	91-36392
Tachometer	91-59339
Universal Carburetor Stand	Obtain Locally
Torx® Screwdriver (15,20,25)	

TORX SCREWDRIVERS

Weber carburetors will have a “star” shaped socket in the head of some screws. A TORX® screwdriver must be used on this type of screw. The sizes used are numbers 15, 20 and 25.

Index

Specifications

Engine Model	Carb Type	Mercury Number (Manufacturer Number)	Primary Jet Size	Secondary Jet Size	Metering Rod Number	Metering Rod Spring Color
4.3LX Alpha	WFB	3304-9565A6 (9600)	.089	.089 in.[1]	16-6857	Yellow
4.3LXH Alpha and Bravo Gen+	WFB	3310-807826 (9666)	.092	.089 in.	16-686457	Green

NOTE: *Some early production engines had stock secondary jet size of .095 in. Refer to "Important Service Information" for more information*

Jet Changes for Altitude

Engine Model	Mercury Number (Manfacturer Number)		Elevation		
			0 - 5000 Feet	5000 - 9000 Feet	9000 - Above
4.3LXH	3310-807826 (9666)	Primary Jet	.092 In		
		Metering Rod	Stock	686864	

UNIT OF MEASUREMENT In. (mm) ALL MEASUREMENTS ARE ± 1/64 In. (0.4 mm).

Carburetor Adjustment Specifications

Engine Model	4.3LX / 4.3LXH Gen +
Carburetor Manufacturer Number	9600, 9666
Float Level	1-9/32 in. (33 mm)
Float Drop	2 in. (51 mm)
Pump Rod Hole Location	Third Hole From End
Accelerator Pump	7/16 in. (11 mm) [1]
Choke Pull-Off	15/64 in. (6 mm)
Choke Coil Rod	Top Of Rod Even With Bottom Of Lever Hole [2]
Preliminary Mixture Idle Screw Setting	1-1/4 Turns

[1] Measured from top of carburetor to bottom of S-link

[2] Remove choke rod from lever hole. Choke held closed and choke rod pushed down with top edge of rod even with bottom edge of hole.

Description

Weber WFB carburetor is unique in design, as the main body and flange are cast as a one piece unit. This, along with the bowl cover, make up the two piece construction which is made of light, durable aluminum to dissipate heat.

There are two separate float circuits. Each float circuit supplies fuel to a primary low speed circuit and a primary and secondary high speed circuit. The bowls are vented to the inside of the air horn. A connecting vent passage effects a balance of the air pressure between the two bowls.

The float needle valves are installed at an angle to provide the best possible seating action on the needles. This provides better needle response to float movement, also.

The high speed circuits use staged step-up rods in the main metering jets to control the amount of fuel admitted to the nozzles. The position of the step-up rod is controlled by manifold vacuum applied to the vacuum piston.

A primary air bleed located in the venturi cluster prevents a rich condition or bog as the high speed circuit is reactivated after deceleration.

Small “L” shaped metal tabs, called “distribution tab(s),” are attached to some venturi clusters and protrude into the air stream at the proper location to aid distribution of fuel on selected applications.

Precautions

⚠ WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠ WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose: gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠ WARNING

Be careful when changing fuel system components: gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area while changing fuel filter. Wipe up any spilled fuel immediately.

Fuel Supply Connections

⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

⚠ WARNING

Make sure no fuel leaks exist, before closing engine hatch.

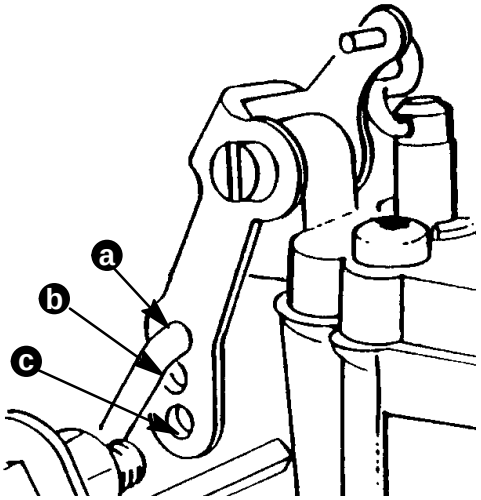
⚠ CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing or water pickup inlet, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

Important Service Information

Weber Carburetor Adjustable Accelerator Pump

The accelerator pump lever on Weber Carburetors has three holes in it. The closest hole to the lever's pivot point is the richest, the second hole is leaner and the hole furthest away is the leanest. All production carbs have the pump rod installed in the closest (richest) hole. If you are having a "rich" bog on acceleration, move the rod to the second or third hole. Weber put the three holes in the lever so the amount of fuel delivered by the accelerator pump could be changed.



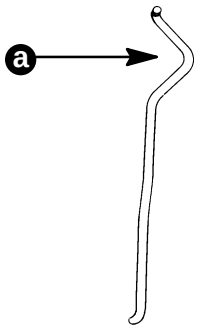
70472

a - Rich
b - Lean
c - Leaner

Hard Starting

If a hard starting condition exists, after engine has not been operated for a period of time, proceed with the following:

1. Before starting engine, remove flame arrestor then operate throttle to see if choke closes.
2. If choke is stuck open, check choke stove link rod and choke linkage on both sides of carburetor for cause of sticking. Possible paint or interference to rod or linkage.
3. If choke plate does not close tight step 2 or 3, then choke link rod will have to be bent to make it shorter so it will close choke plate completely.



73716

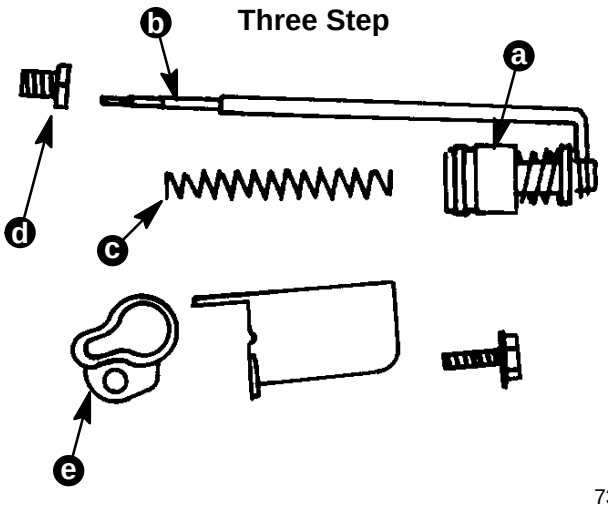
a - Bend Here To Shorten

4. After installing, ensure that the rod does not rub against stove cover or carburetor throughout its travel.

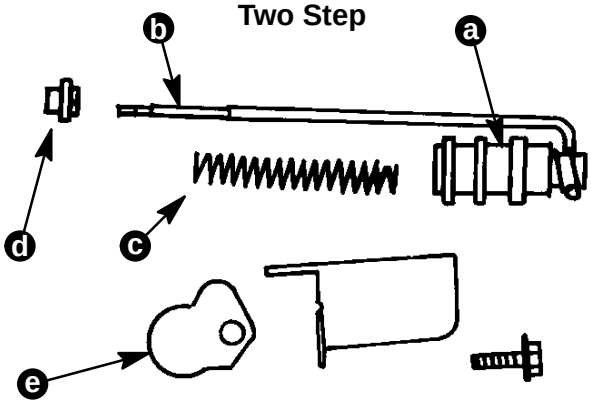
Carburetor Metering Rod And Jet Identification

METERING ASSEMBLY

The metering rod assemblies are different in the following ways:



73732

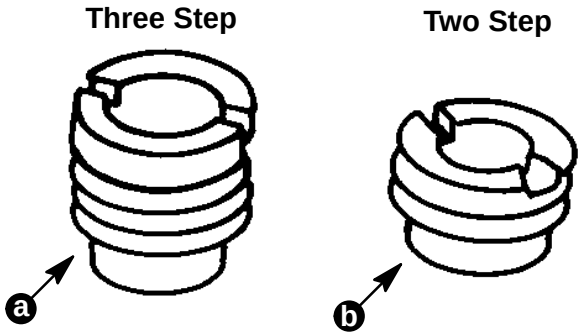


73729

a - Piston
b - Metering Rod
c - Spring
d - Jet
e - Piston Cover

METERING JETS

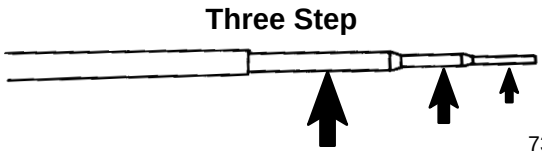
The metering jets in this carburetor are taller than the jets in a standard carburetor.



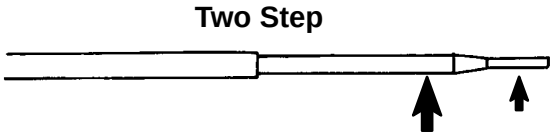
73728

a - Three Step Metering Rod
b - Two Step Metering Rod

METERING ROD HAS “THREE STEPS” -VS- TWO

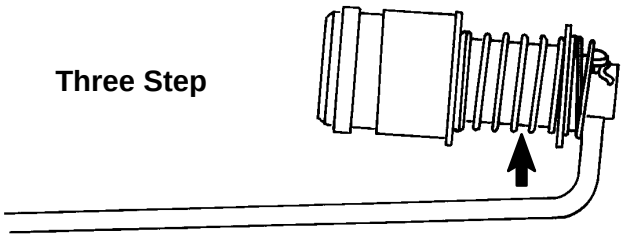


73726

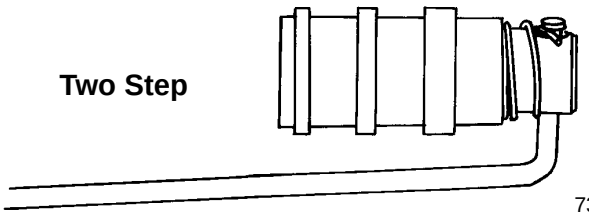


73724

PISTON SHAPE IS DIFFERENT AND HAS A SECOND SPRING



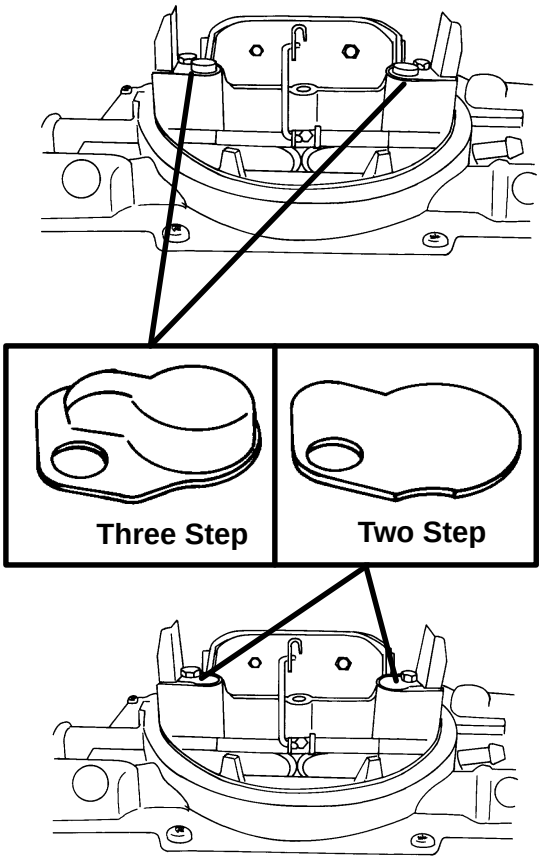
73730



73727

Index

PISTON ASSEMBLY COVER IS HIGHER

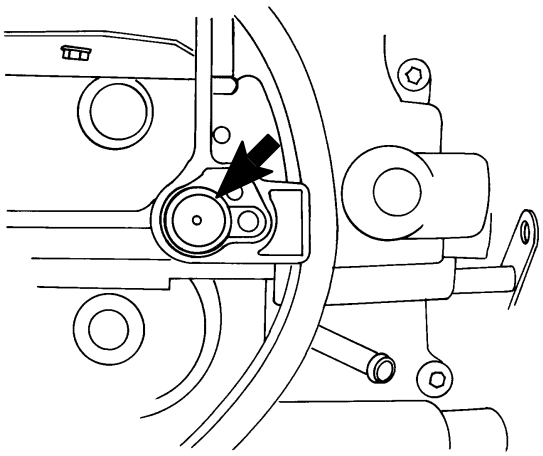


73735

73725

73736

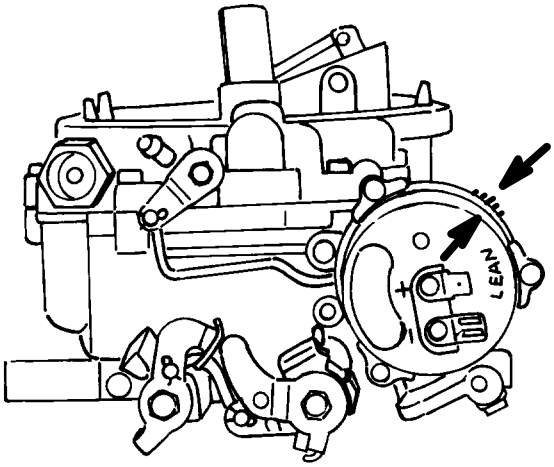
PISTON BORE HAS A STEP ON THREE STEP MODEL



73737

ELECTRIC CHOKE

The electric choke should be set with marks aligned.



74104

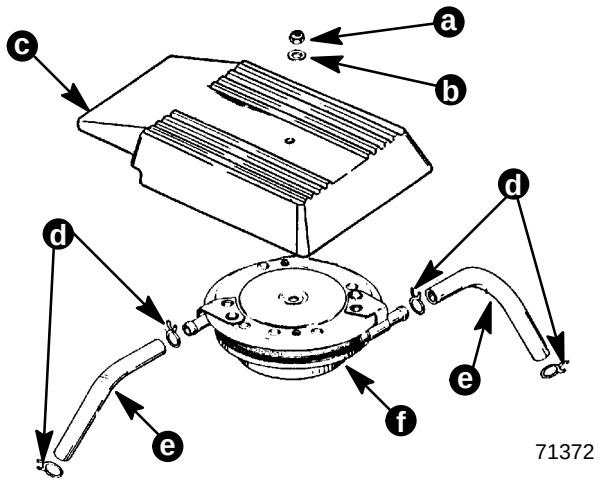
Maintenance

Flame Arrestor

NOTICE
Refer to "Precautions," in this section, BEFORE proceeding.

5. Remove (in the following order):
   a. Nut
   b. Sealing washer
   c. Carburetor cover
   d. Crankcase ventilation hoses from flame arrestor and rocker arm covers
   e. Flame arrestor
6. Clean and inspect:
   a. Clean flame arrestor in solvent and blow dry with compressed air.
   b. Clean crankcase ventilation hoses.
   c. Inspect crankcase ventilation hoses for cracks or deterioration, and replace if necessary.

7. Install (in the following order):
   a. Flame arrestor
   b. Crankcase ventilation hoses to flame arrestor and rocker arm covers
   c. Carburetor cover
   d. Sealing washer
   e. Nut (tighten securely)



71372

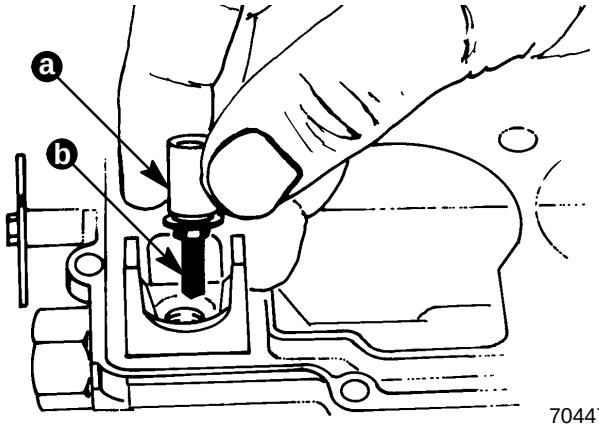
Flame Arrestor with Carburetor Cover (Typical)

a - Nut
b - Sealing Washer
c - Carburetor Cover
d - Sta-Strap
e - Crankcase Cover
f - Crankcase Ventilation Hose
g - Flame Arrestor

Fuel Filter

NOTICE
Refer to "Precautions," in this section, BEFORE proceeding.

Carburetor inlet fuel filter is installed in bottom side of fuel inlet seat (in the carburetor top). Refer to "Disassembly" and "Reassembly" to service.



70447

a - Fuel Inlet Seat (with Gasket)
b - Fuel Inlet Filter

Index

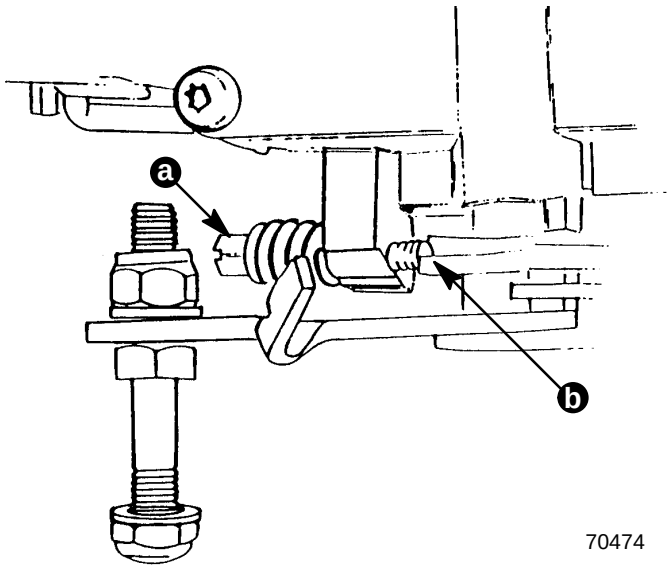
Adjustments

NOTICE
Refer to "Precautions," in this section, BEFORE proceeding.

Accelerator Pump

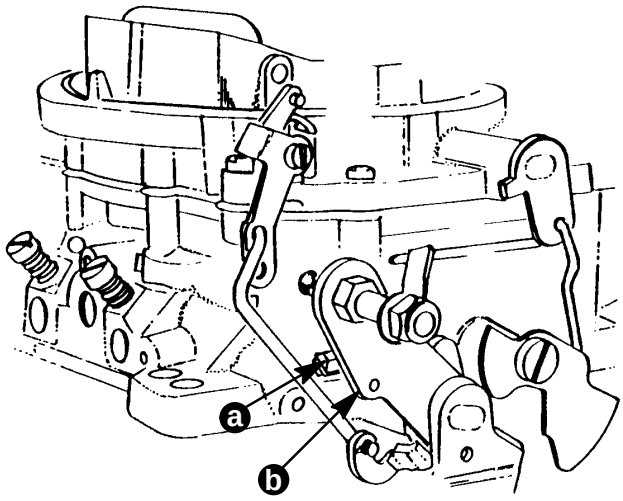
IMPORTANT: Refer to "Important Service Information" in this section, regarding the three accelerator pump linkage holes and placement of linkage rod.

1. Back out idle speed screw until it no longer contacts throttle lever.



70474

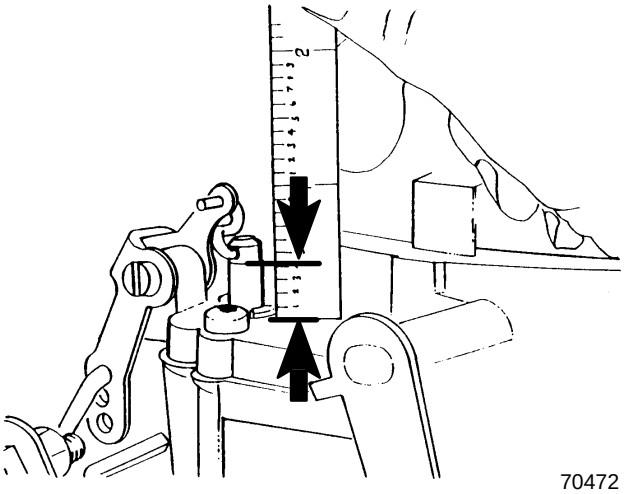
a - Idle Speed Screw
b - Throttle Lever Contact Point



70473

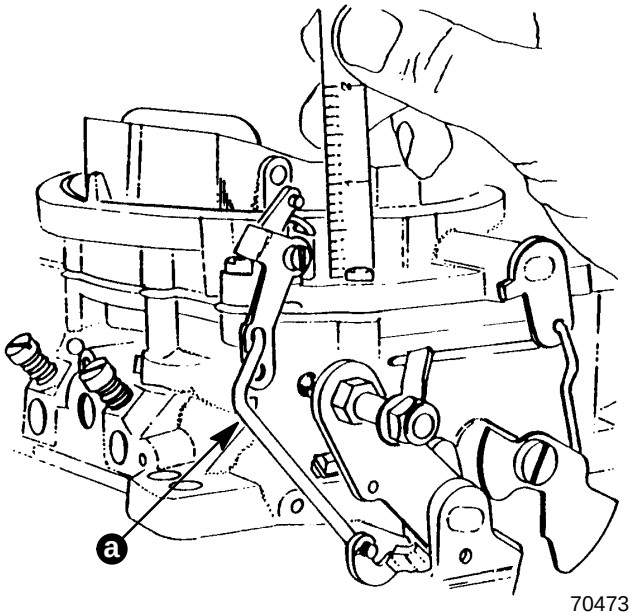
a - Idle Speed Screw
b - Throttle Lever

2. Close throttle valves completely.
3. Accelerator pump is set at 7/16 in. (11 mm), which is measured from the carburetor top to the bottom of the S-link as shown.



70472

4. Adjustment of accelerator pump is done by bending the linkage as necessary to achieve the proper dimension as stated above.



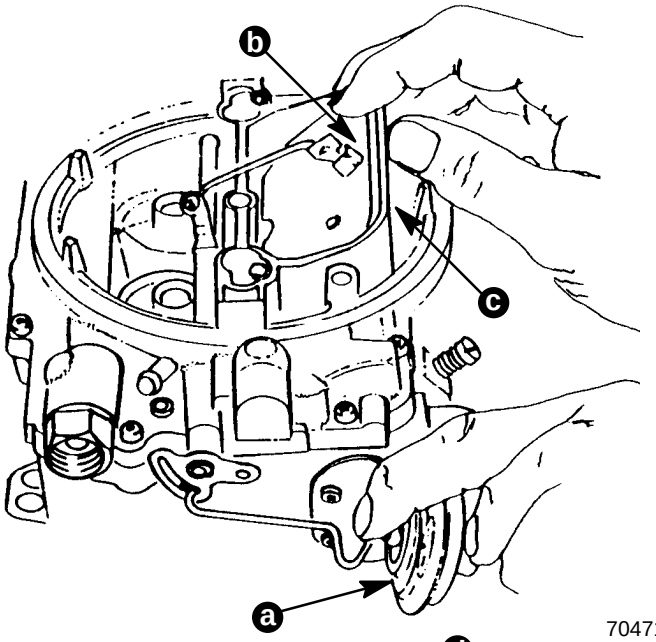
70473

a - Bend Here

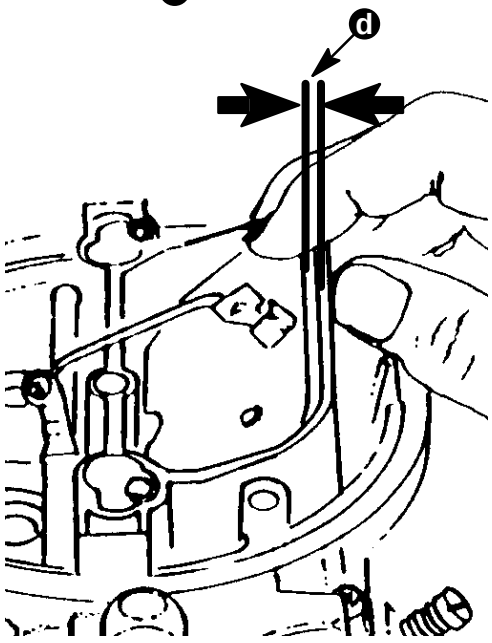
Index

Choke Pull-Off

1. Choke pull-off is checked by holding in on vacuum diaphragm and attempting to close choke plate. The gap between the plate and housing is to be set at15/64 in. (6 mm).



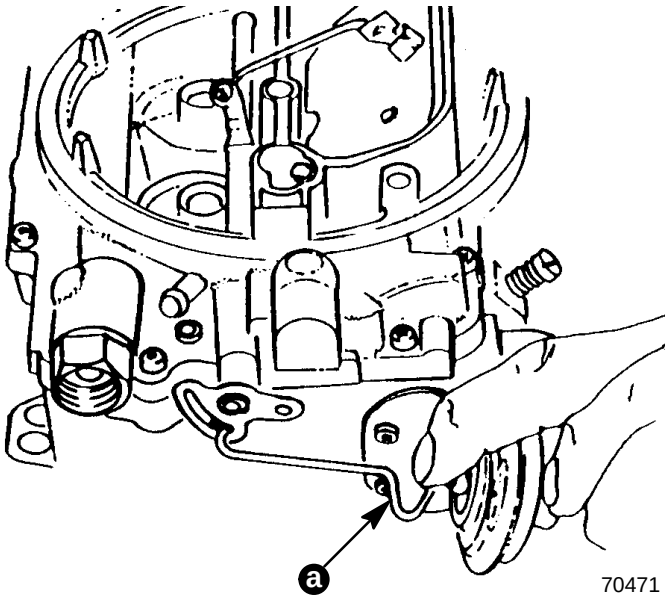
70471



70471

a - Vacuum Diaphragm
b - Choke Plate
c - Housing
d - Gap Measurement

2. Bend choke pull-off linkage to achieve setting given in Step 1.

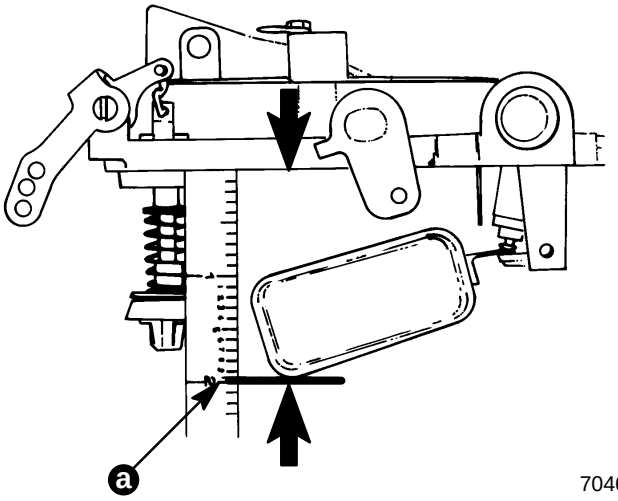


70471

a - linkage (Bend)

Float Drop

1. Measure float drop from bottom side of carburetor top to toe of float (lowest part), as shown. It must be set at 2 in. (51 mm).

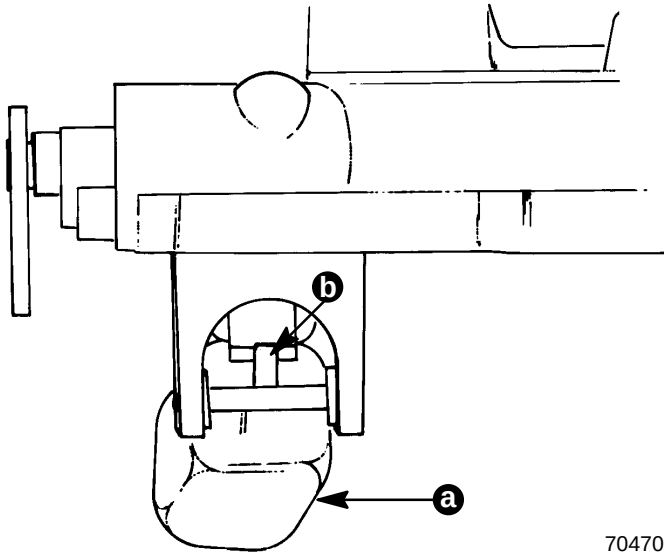


70469

a - Drop Measurement

2. If float drop is not correct, hold hinge pin firmly and bend tab shown, as needed.

IMPORTANT: Do not put pressure on fuel needle valve and seat while bending tab, or damage may result.

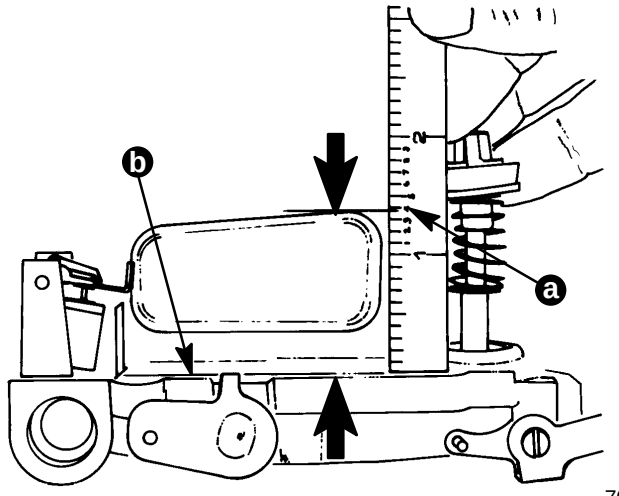


70470

a - Float
b - Tab (Bend)

Float Level

1. Measure float level from bottom side of carburetor top (with gasket in place) to toe of float as shown. It must be set at 1-9/32 in. (33 mm).

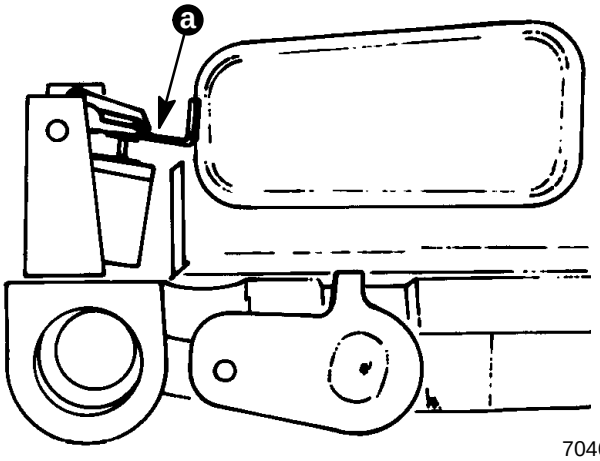


70468

a - Float Level Measurement
b - Gasket

2. If float level requires adjustment, hold hinge pin firmly and bend float arm shown, as needed.

IMPORTANT: Do not put pressure on fuel needle valve and seat while bending tab, or damage may result.



70468

a - Float Level Tab (Bend)

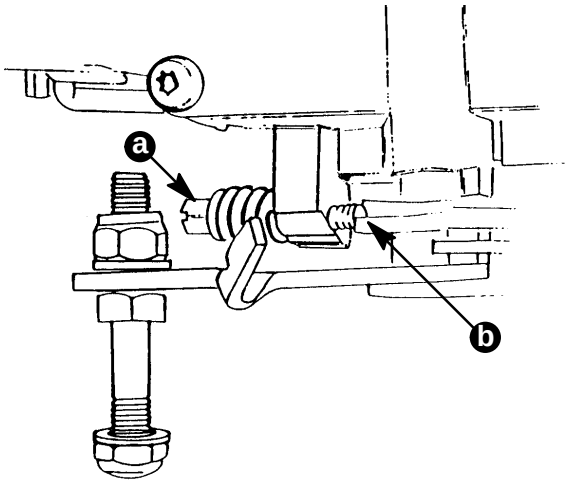
Idle Speed and Mixture Adjustments

Thunderbolt IV Equipped Engines

PRELIMINARY IDLE SPEED AND MIXTURE

Initial start settings are given following. Make final adjustment with engine running (refer to “Final Idle Speed and Mixture”).

1. Turn idle speed screw until it contacts throttle lever.

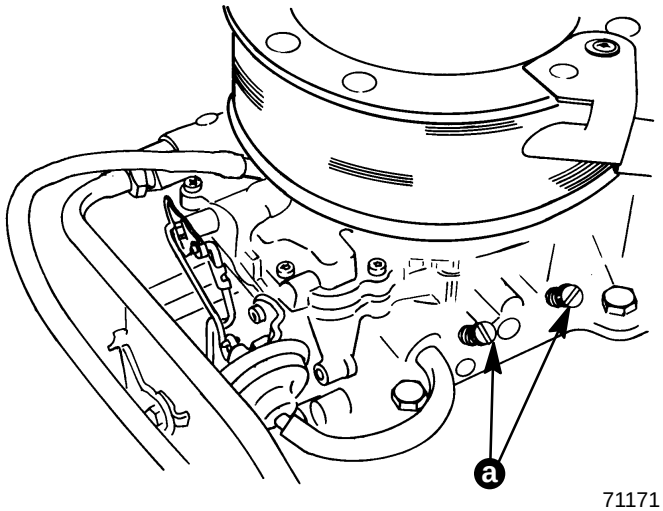


70474

a - Idle Speed Screw
b - Throttle Lever Contact Point

2. Turn idle mixture screws (needles) in (clockwise) until LIGHTLY seated, then back out 1-1/4 turns.

IMPORTANT: Do not turn idle mixture screws tightly against seat, as damage to seat and/or needle may result.



71171

a - Idle Mixture Screws (Needles)

FINAL IDLE SPEED AND MIXTURE

IMPORTANT: Boat MUST BE in the water and engine at normal operating temperature to accurately check and adjust idle speed and mixture.

Carburetor should be set so that engine idles as smoothly as possible, with boat in the water, engine normal operating temperature and drive unit in forward gear. To adjust idle speed and mixture, proceed as follows:

IMPORTANT: DO NOT attempt to compensate for other engine problems (incorrect ignition timing, faulty ignition components, low compression, vacuum leaks, etc.) with carburetor adjustments. This will only cover the problem, which must be corrected if engine is to achieve maximum fuel economy and performance.

1. Connect a shop tachometer to engine.

IMPORTANT: DO NOT turn idle mixture screws (needles) tightly into seat, as damage to needle and/or seat may result.

2. If a new or rebuilt carburetor has been installed, turn each idle mixture screw until it LIGHTLY contacts seat (if not already accomplished), then back out 1-1/4 turns. This will provide a sufficient setting to allow starting the engine.
3. Start engine and run at 1500 RPM until engine reaches normal operating temperature.

⚠WARNING

DO NOT leave helm unattended while performing idle speed and mixture adjustments, following. BE CAREFUL NOT TO ACCIDENTALLY ACCELERATE ENGINE WHILE PERFORMING ADJUSTMENTS.

4. With boat in open water, place remote control in forward gear, idle position.
5. Disconnect throttle cable barrel from anchor stud. BE SURE NOT TO LOSE SPACER ON ANCHOR STUD.
6. Adjust idle speed adjustment screw to obtain specified idle RPM. (Refer to Section 1B - “Tune-Up Specifications” charts.)

NOTE:Idle speed must be at specified RPM or less. Or engine will be operating on the off idle circuit. Mixture screw adjustments will be ineffective if this condition exists.

7. With engine running at or just below specified idle RPM, adjust idle mixture screws as follows:
   a. Turn idle mixture needle in (clockwise) until the engine speed begins to decrease due to LEAN mixture.
   b. Turn same idle mixture screw outward (counterclockwise) until the engine speed begins to decrease due to a RICH mixture.
   c. Turn screw in to a point between these two extremes to obtain maximum engine smoothness and RPM.
   d. Repeat procedure with other mixture screw.
   e. Readjust idle speed adjusting screw, if necessary, to obtain specified idle RPM.
8. Place remote control in neutral. Turn ignition OFF.
9. Accelerator pump linkage should be rechecked at this time. Refer to Steps 3 and 4, of Adjustments –“Accelerator Pump”, as previously outlined and verify pump is set at 7/16 in. (11mm) as specified.
10. Refer to SECTION 2. Install and adjust throttle cable following instructions appropriate to your power package.

Thunderbolt V Equipped Engines

ADJUSTING IDLE MIXTURE

The procedure for adjusting carburetor idle mixture can be found in the appropriate engine service manual. This procedure also requires that the ignition module be locked in the “Base Timing Mode”.

IMPORTANT: In order to properly set idle mixture, the ignition module MUST BE locked in the “Base Timing Mode”. This is necessary because of the “Idle Speed Control” feature that exists in the ignition module. See information on the previous pages about this feature.

1. Using a jumper wire, connect the ignition system timing lead “13” (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the “Base Timing Mode”.
2. Adjust idle mixture following the procedure in the appropriate engine service manual.
3. Remove the jumper wire from the timing terminal.

ADJUSTING ENGINE IDLE SPEED

This procedure should be done with boat in the water, drive unit in neutral and engine at normal operating temperature. Refer to the Operation and Maintenance Manual for the correct idle speed.

1. Disconnect the throttle cable from carburetor.

IMPORTANT: In order to properly set idle speed, the ignition module MUST BE locked in the “Base Timing Mode”. This is necessary because of the “Idle Speed Control” feature that exists in the ignition module. See information on the previous pages about this feature.

2. Connect a shop tachometer to engine.
3. Using a jumper wire, connect the ignition system timing lead “13” (PUR/WHT wire) to a good engine ground (–). This locks the ignition module into the “Base Timing Mode”.
4. Start engine and allow it to reach normal operating temperature. Place the remote control lever in forward gear, idle position.
5. Adjust idle speed to recommended RPM.
6. Stop engine. Readjust cable barrel and reinstall the throttle.

IMPORTANT: Be sure to disconnect the jumper wire from the ignition system test terminal before attempting to resume normal operations. If the jumper wire is left in place, the ignition module will operate in the “Base Timing Mode”. This means that the additional timing advance features would not be functioning.

7. Remove the jumper wire from the timing terminal.

Repair

NOTICE
Refer to “Precautions,” in this section, BEFORE proceeding.

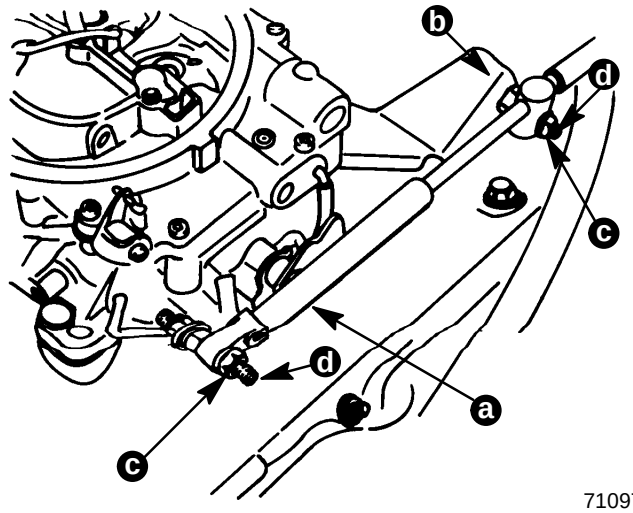
Removal

IMPORTANT: Carburetor malfunctions are, in many cases, caused by the presence of dirt, water or other foreign matter in carburetor. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may, then, be inspected for contamination as carburetor is disassembled.

1. Turn off fuel supply at fuel tank.
2. Remove carburetor cover. Remove crankcase ventilation hoses from flame arrestor, then remove flame arrestor.

IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and foreign material from falling into bores.

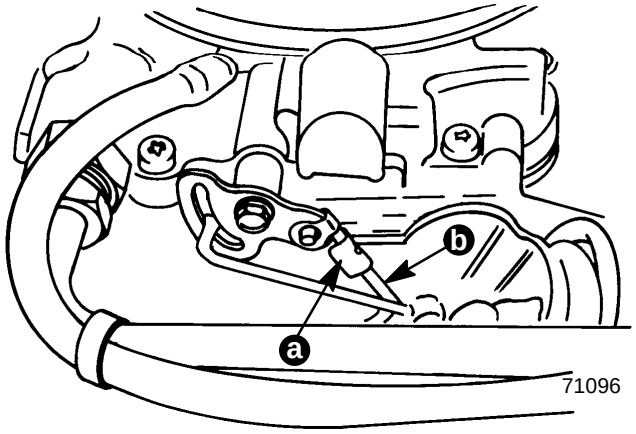
3. Disconnect throttle cable attaching hardware from throttle bracket and throttle lever anchor studs. Remove throttle cable.



71097

a - Throttle Cable
b - Bracket
c - Attaching Hardware
d - Anchor Studs

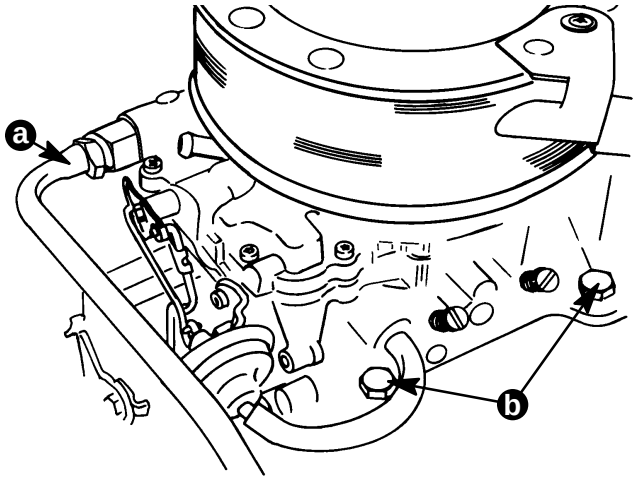
4. Disconnect retaining clip and choke linkage rod.



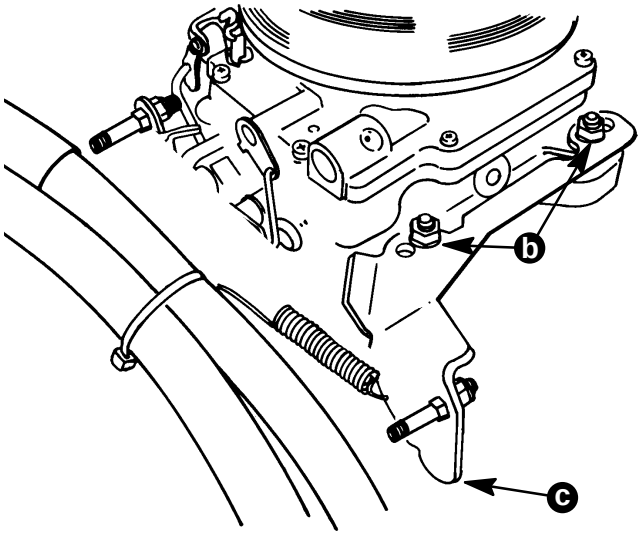
71096

a - Retaining Clip
b - Linkage Rod

5. Remove fuel line and carburetor attaching hardware. Remove carburetor and throttle bracket. Discard old gasket from carburetor.



71173



71172

a - Fuel Line
b - Attaching Hardware
c - Throttle Bracket

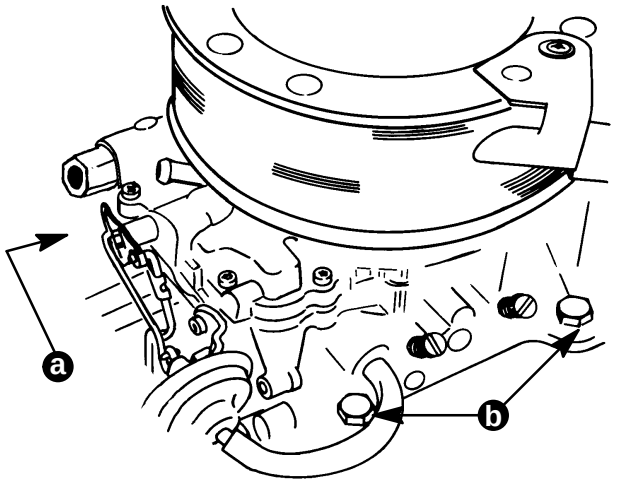
Index

6. Remove adaptor/wedge plate (if so equipped) from manifold and discard old gasket.
7. Place a clean cloth over intake manifold openings.

IMPORTANT: Covering intake manifold prevents entry of dirt or foreign material through openings.

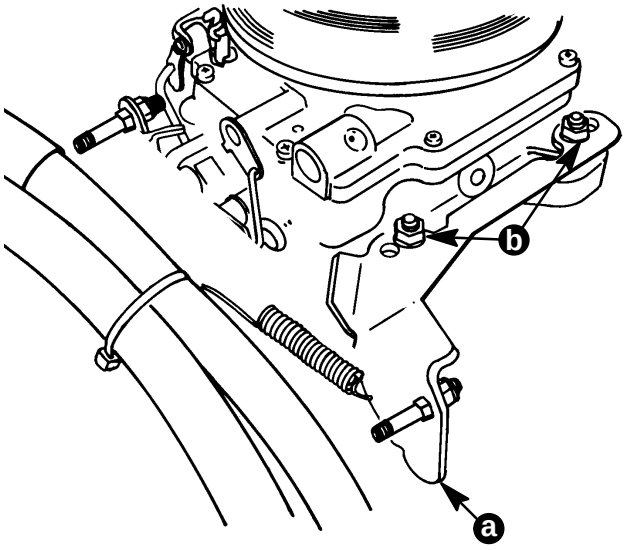
Installation

1. Place appropriate new gasket on intake manifold.
2. If so equipped, install adaptor or wedge plate, depending on model. Place appropriate new gasket on top.
3. Install carburetor and throttle bracket with attaching hardware. Torque fasteners to 132 lb. in. (15 N·m).



71173

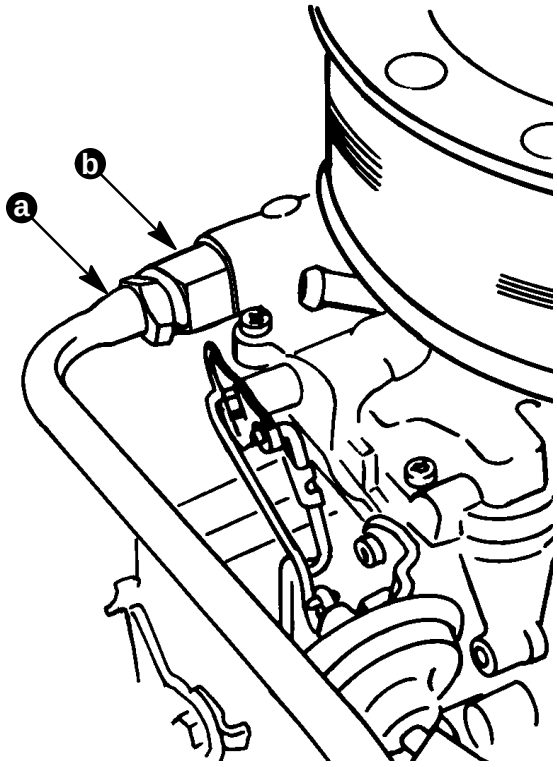
a - Throttle Bracket (Not Visible In This View)
b - Attaching Hardware



71172

a - Throttle Bracket
b - Attaching Hardware

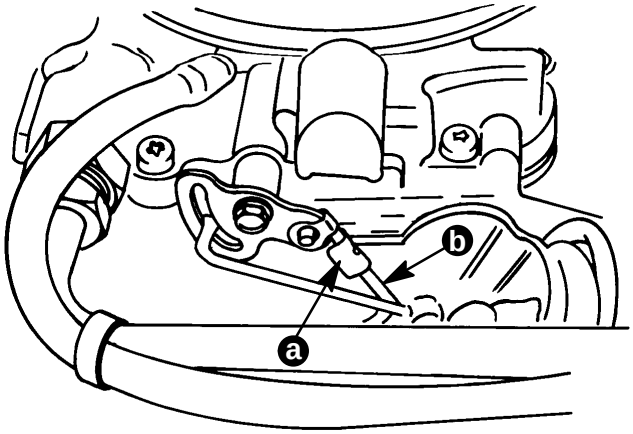
4. Install fuel line. To prevent over-tightening, hold fuel inlet filter nut with suitable wrench and tighten fuel line connector securely.



71173

a - Fuel Line
b - Fuel Inlet Filter Nut

5. Connect choke linkage rod and install retaining clip.



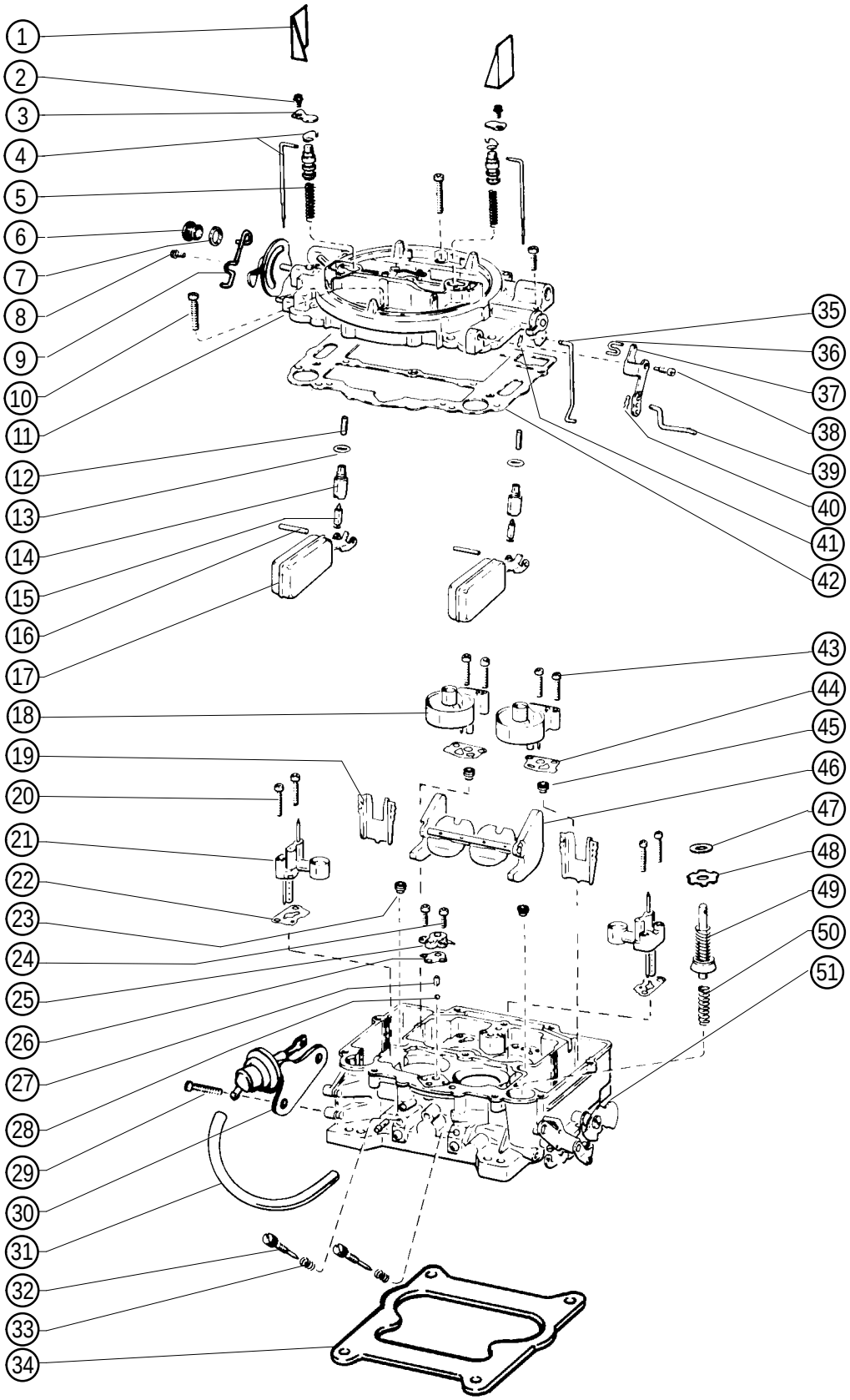
71096

a - Clip
b - Linkage Rod

6. Refer to Section 2. **Install and adjust** throttle cable following instructions appropriate to your power package.
7. Install flame arrestor and tighten nut securely.
8. Reconnect battery cables to battery by first installing positive battery cable to positive (+) battery terminal. Tighten clamp securely. Then, install negative battery cable to negative (–) battery terminal. Tighten clamp securely.
9. Turn on fuel supply at fuel tank.
10. Start engine and check for gasoline leaks. If leaks exist, **STOP ENGINE IMMEDIATELY** and recheck connections.
11. Adjust idle speed and idle mixture, as previously outlined under “Adjustments.”

Exploded View

Weber Carburetor



Index

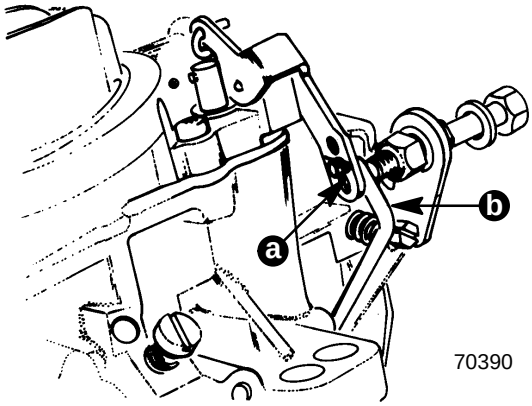
1-Air Deflector (2)
2-Screw (2)
3-Cover, Metering Rod (2)
4-Metering Rod Assembly (2)
5-Spring, Metering Rod (2)
6-Fuel Inlet Fitting
7-Sealing Washer
8-Screw
9-Linkage Rod, Choke Pull-Off
10- Screw
11- Air Horn (Carburetor Top)
12- Filter, Fuel Inlet (2)
13- Gasket (2)
14- Seat, Fuel Inlet (2)
15- Needle Valve, Fuel Inlet (2)
16- Pin (2)
17- Float (2)
18- Secondary Venturi Cluster (2)
19- Baffle Plate, Float Bowl (2)
20- Screw (4)
21- Primary Venturi Cluster (2)
22- Gasket (2)
23- Jet, Primary Fuel (2)
24- Screw (2)
25- Fuel Pump Injector Housing
26- Gasket
27- Check-Weight (or Check-Spring, if So Equipped)
28- Check-Ball
29- Screw
30- Diaphragm, Choke Pull-Off
31- Vacuum Hose
32- Idle Mixture Screw (2)
33- Spring, Idle Mixture Screw (2)
34- Gasket, Carburetor Base
35- Linkage Rod, Choke Plate
36- S-Link
37- Accelerator Pump Lever
38- Screw
39- Linkage Rod, Accelerator Pump
40- Wire Clip
41- Wire Clip
42- Gasket
43- Screw (4)
44- Gasket (2)
45- Jet, Secondary Fuel (2)
46- Secondary Air Valve and Weight Assembly
47- Plunger Washer
48- Plunger Guide
49- Accelerator Pump
50- Spring, Accelerator Pump
51- Float Bowl/Body (Carburetor Bottom)

Disassembly

The following is a step-by-step procedure for completely overhauling carburetor after removal from engine. In many cases, however, complete overhaul is not necessary and, in these cases, only the steps required to repair the carburetor malfunction should be performed. Read the instructions carefully to prevent doing unnecessary steps.

IMPORTANT: Before performing any service on carburetor, it is essential that carburetor be placed in a holding fixture to prevent possible damage to throttle valves.

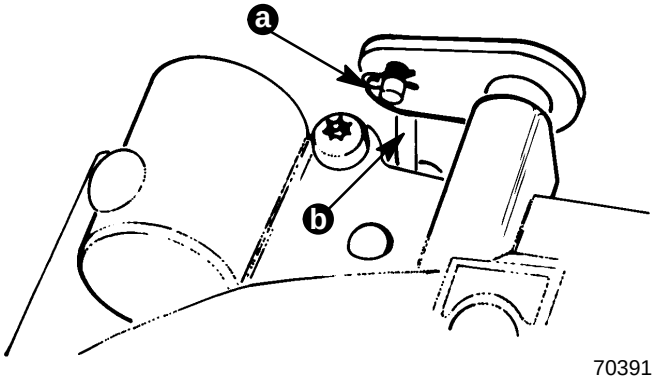
1. Remove wire clip to disconnect accelerator pump linkage.



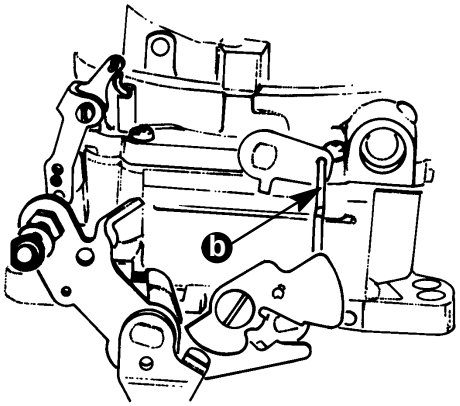
a - Wire Clip
b - Accelerator Pump Linkage Rod

Index

2. Remove wire clip to disconnect choke plate linkage.



70391

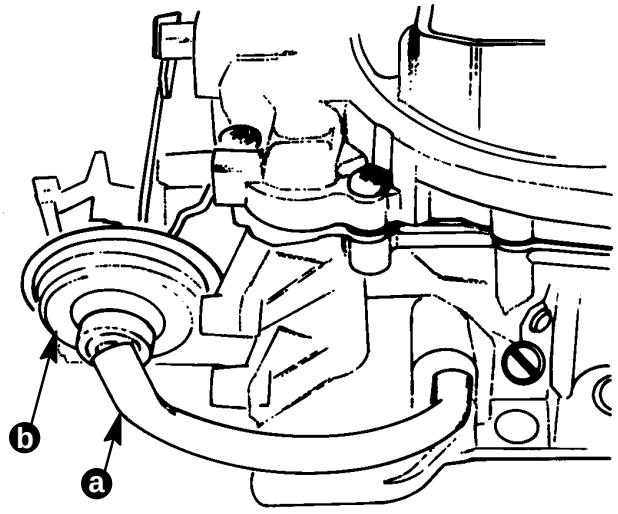


70392

a - Wire Clip
b - Choke Plate Linkage Rod

NOTE: Do not remove vacuum hose if not servicing diaphragm.

3. Disconnect vacuum hose from choke pull-off diaphragm.

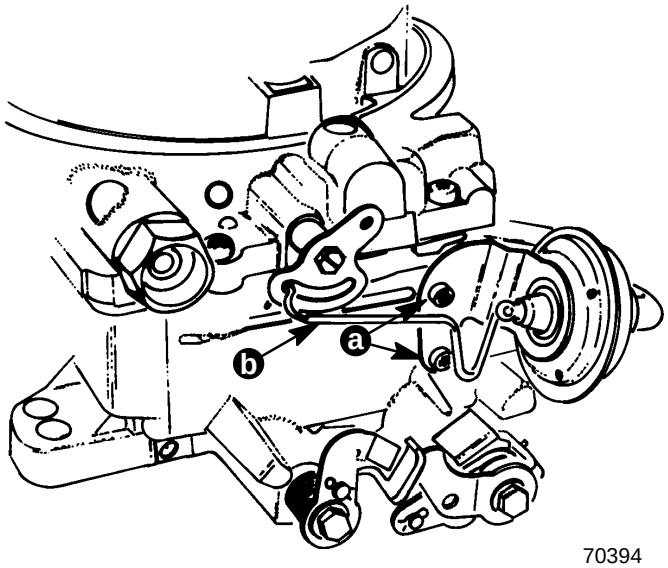


70393

a - Vacuum Hose
b - Choke Pull-Off Diaphragm

4. Remove screws from choke pull-off diaphragm bracket to disengage choke pull-off linkage.

NOTE:Depending on amount of service required, it may not be necessary to remove diaphragm and bracket.



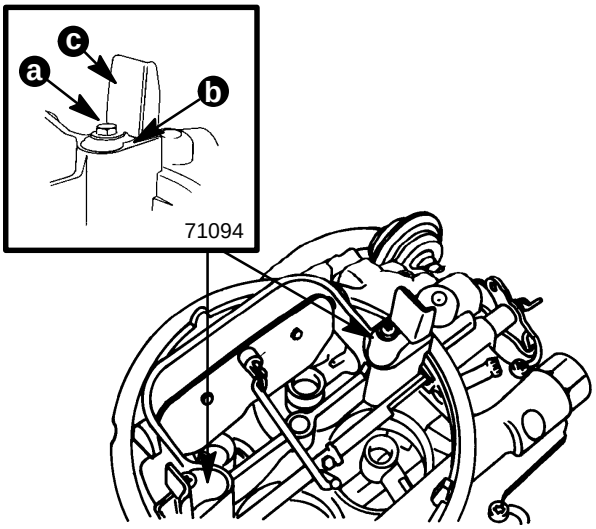
70394

a - Screws
b - Linkage Rod

IMPORTANT: Metering rods should always be removed before separating top and bottom halves of carburetor.

Index

5. Loosen (not necessary to remove, depending on amount of service required) metering rod cover screws. Turn cover, or remove, to expose metering rod.

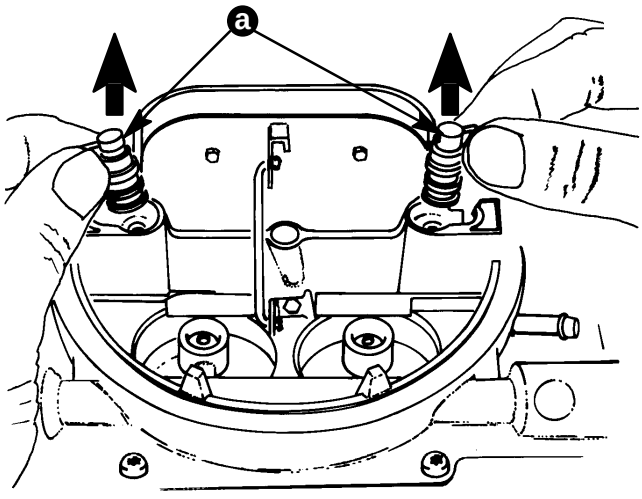


71095

a - Screws
b - Metering Rod Cover(s)
c - Air Deflectors If Equipped)

IMPORTANT: Be careful not to mix metering rods when removing them.

6. Carefully lift metering rod assemblies straight out.

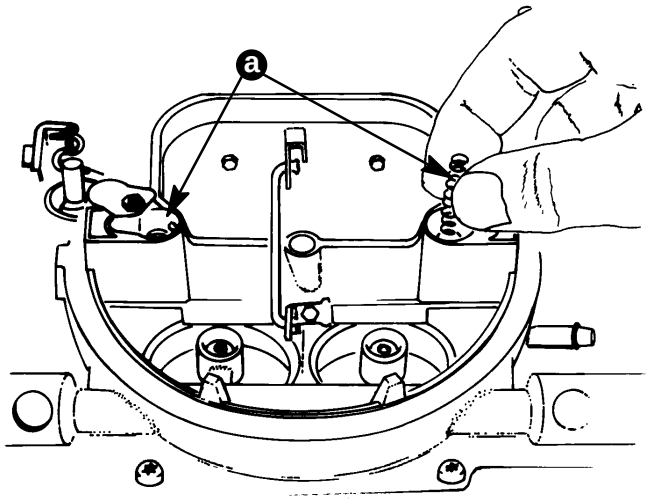


70396

a - Metering Rod Assembly(s)

7. Remove metering rod springs.

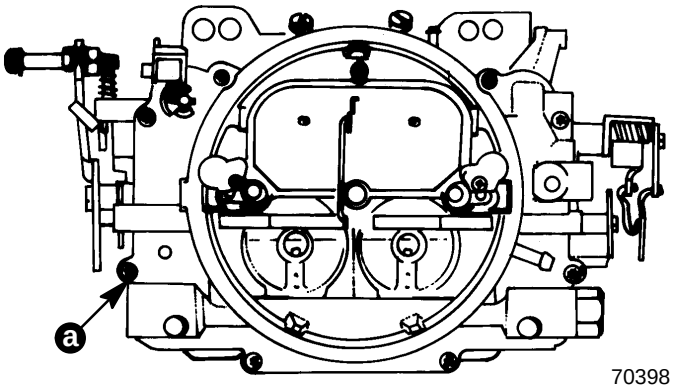
IMPORTANT: Metering rod springs are color coded and should not be interchanged with other carburetors.



70397

a - Spring(s)

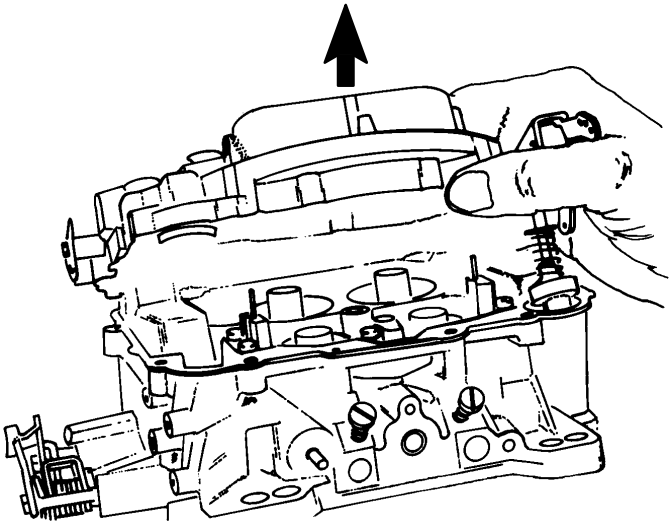
8. Remove nine screws to separate top and bottom halves of carburetor.



70398

a - Screw(s)

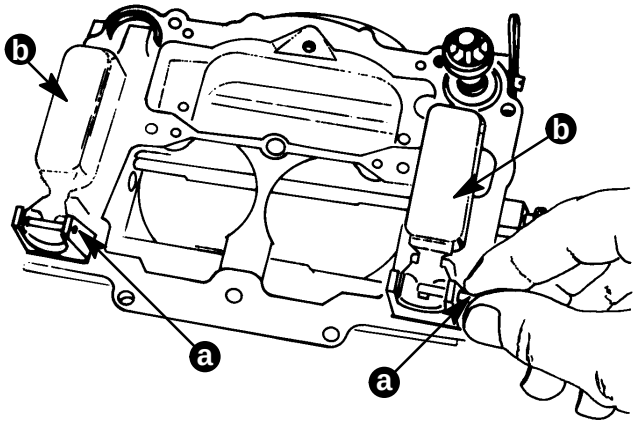
9. Carefully lift off carburetor top and disconnect choke linkage.



70399

10. Slide pin out to remove the float.

IMPORTANT: Be careful not to mix up floats after removal.

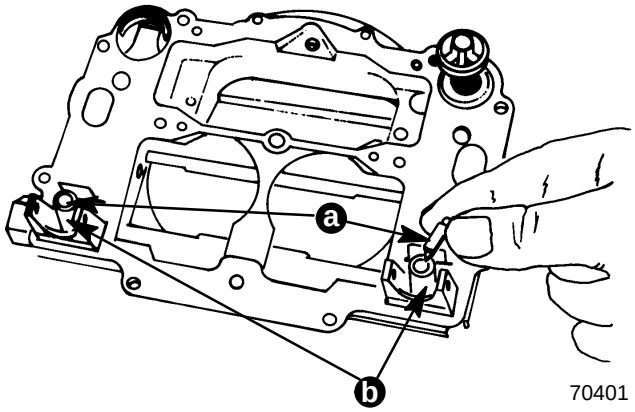


70400

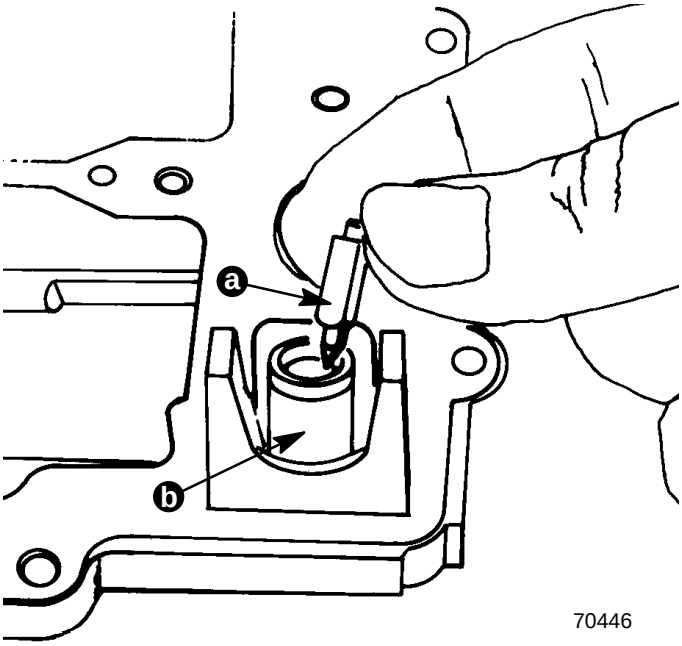
a - Pin(s)
b - Float(s)

11. Remove inlet needle from seat.

IMPORTANT: Be careful not to mix up inlet needles and seats after removal.



70401

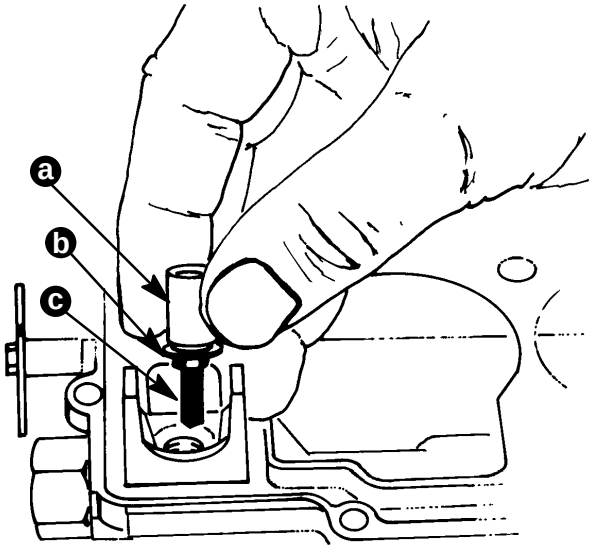


70446

a - Inlets Needle(s)
b - Seat(s)

12. Remove seat, gasket, and inlet filter.

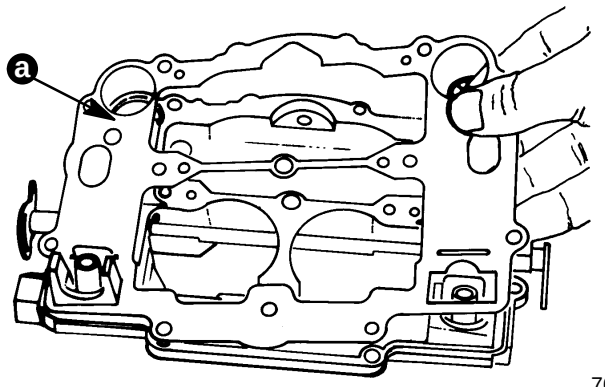
IMPORTANT: Be careful not to mix up seats after removal.



70447

a - Seat
b - Gasket
c - Inlet Filter

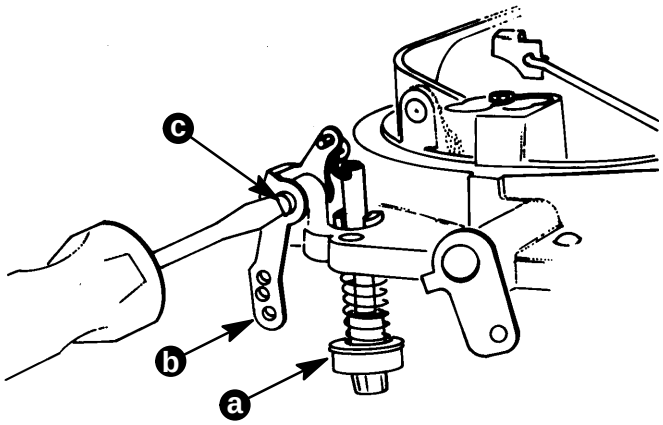
13. Remove gasket from top of carburetor.



70448

a - Gasket

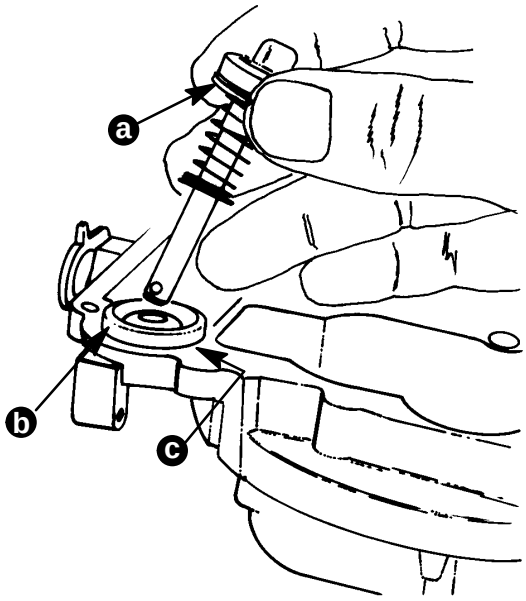
14. Remove accelerator pump lever.



70449

a - Accelerator Pump
b - Accelerator Pump Lever
c - Retaining Screw

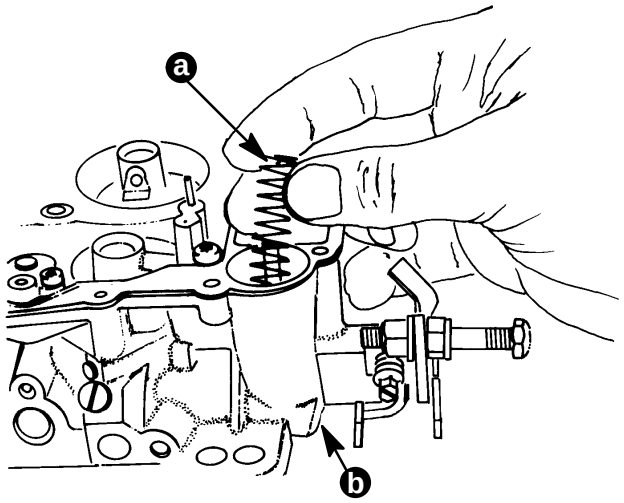
15. Remove accelerator pump.



70450

a - Accelerator Pump
b - Plunger Guide
c - Plunger Washer (Not Visible In This View)

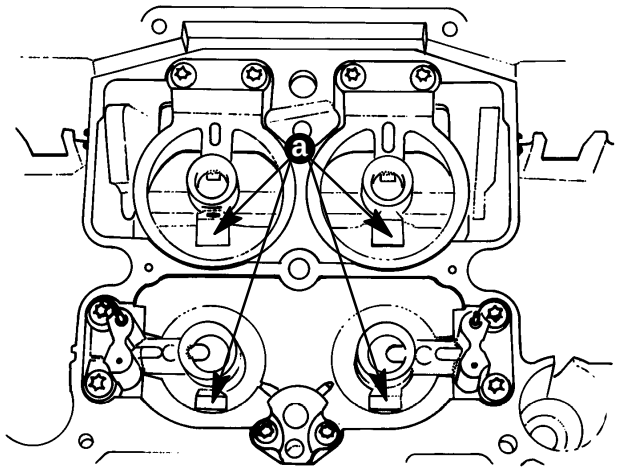
16. Remove accelerator pump spring from bottom half of carburetor.



70451

a - Accelerator Pump Spring
b - Carburetor Bottom

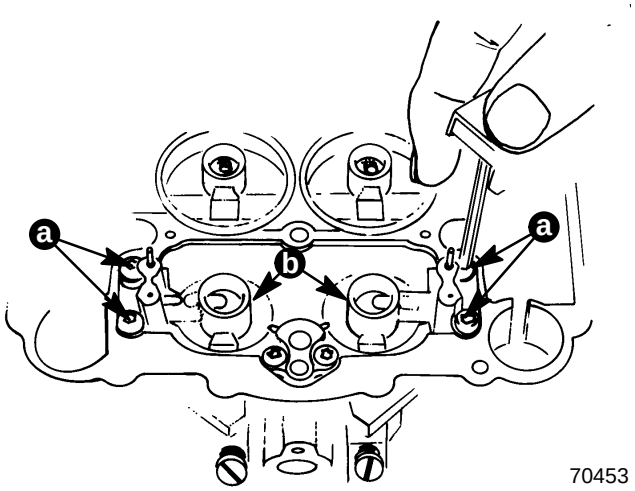
IMPORTANT: Before removing venturi clusters, it is important to note which clusters are equipped with a "distribution tab." This distribution tab arrangement varies from one carburetor to another.



70452

a - Distribution Tab(s) Location And Total Number May Vary

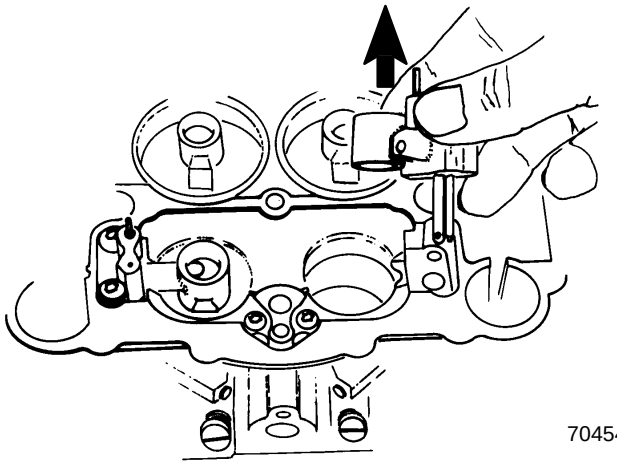
17. Remove two screws that secure primary venturi cluster.



70453

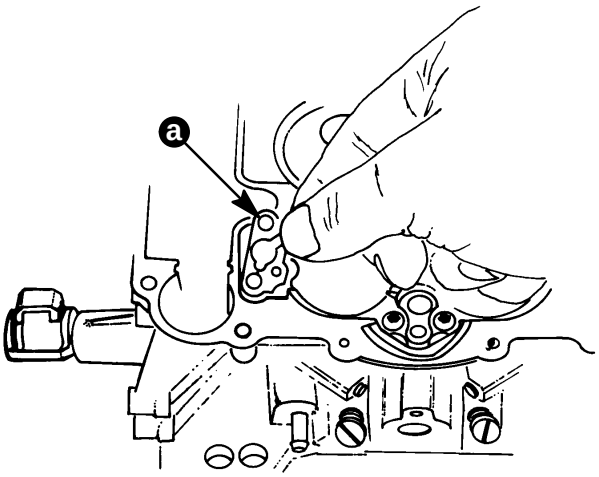
a - Screw(s) Two On Each Side
b - Primary Venturi Cluster(s)

18. Remove primary venturi cluster by lifting straight up.



70454

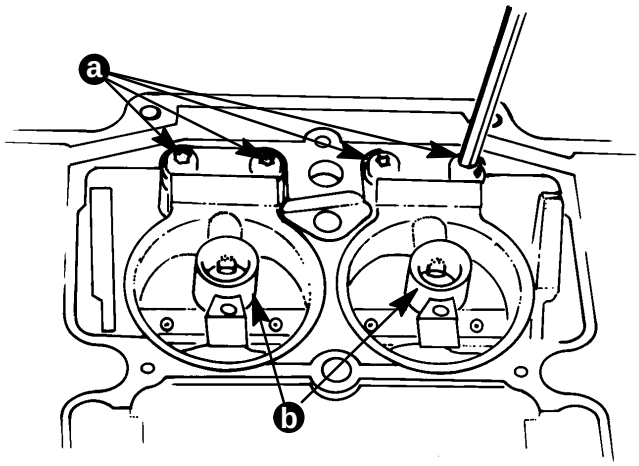
19. Remove gasket from beneath venturi cluster.



70455

a - Gasket Primary Venturi Cluster

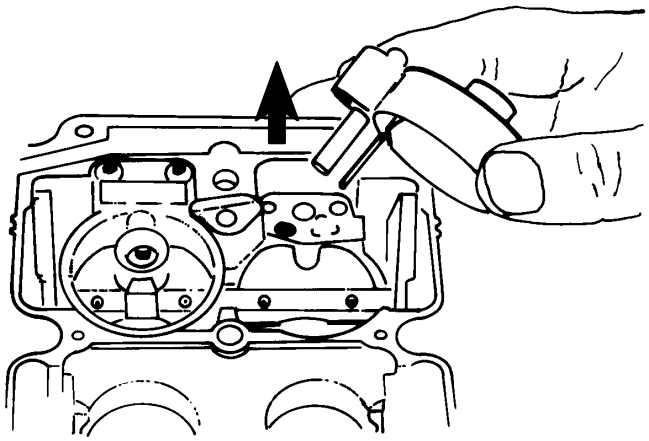
20. Remove two screws that secure secondary venturi clusters.



70456

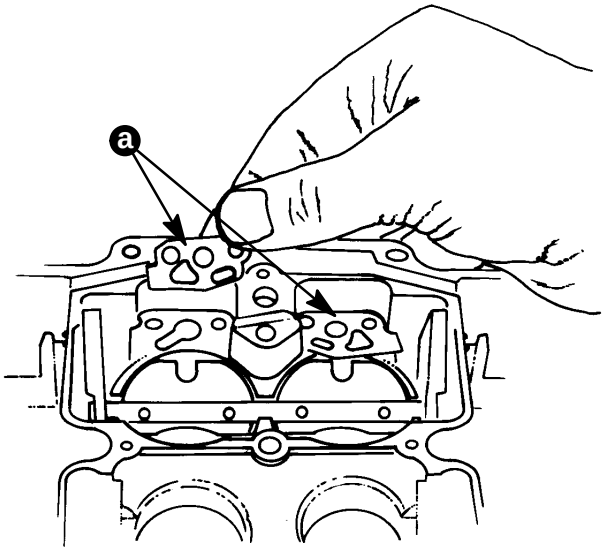
a - Screw(s) Two Each Side
b - Secondary Venturi Cluster(s)

21. Remove secondary venturi cluster by lifting it straight up.



70457

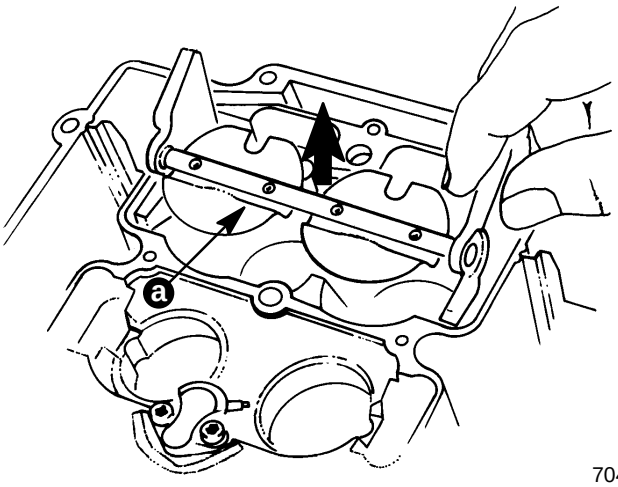
22. Remove gaskets from beneath secondary venturi clusters.



70458

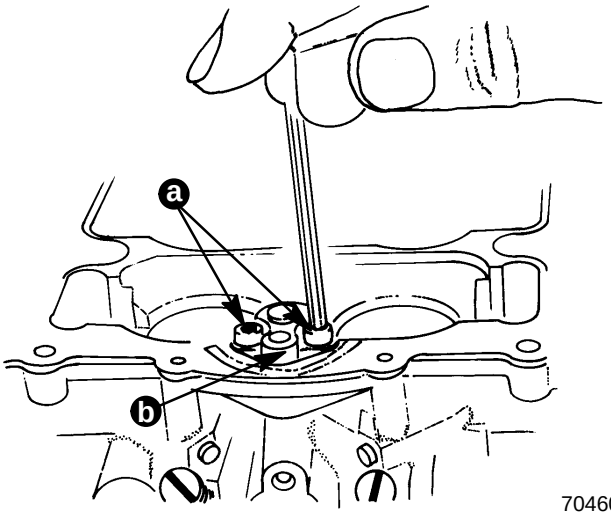
a - Gasket, Secondary Venturi Cluster

23. Remove secondary air valve and weight assembly by lifting it straight out.



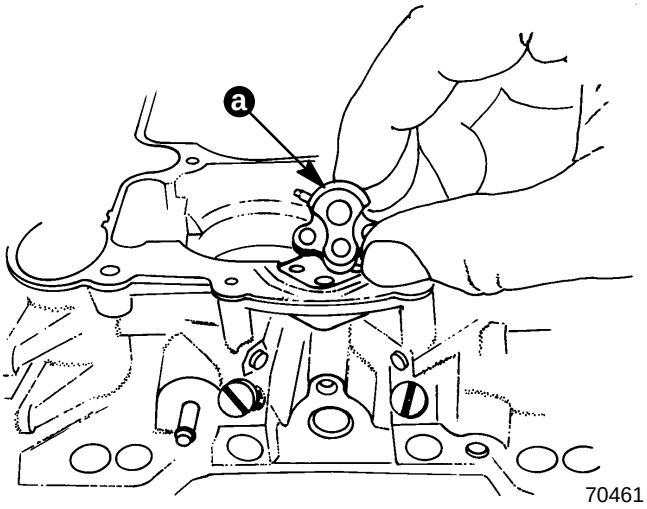
a - Secondary Air Valve And Weight Assembly

24. Remove two screws that secure pump jet housing.



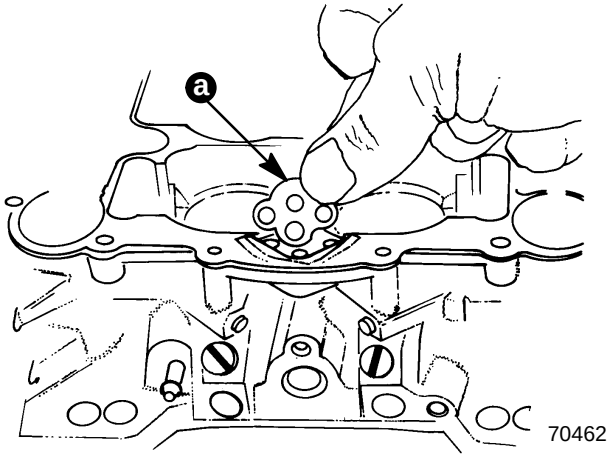
a - Screw(s)
b - Pump Jet Housing

25. Remove pump jet housing.



a - Pump Jet Housing

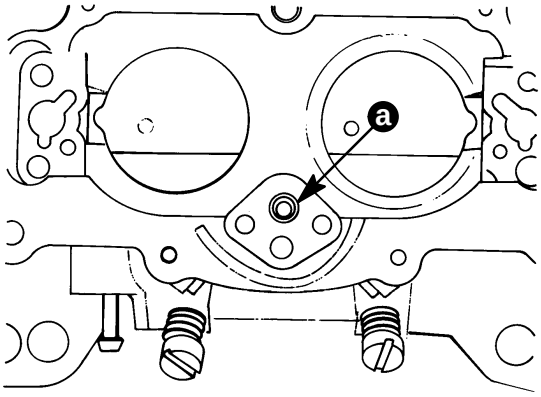
26. Remove gasket from beneath pump jet housing.



a - Gasket, Pump Jet Housing

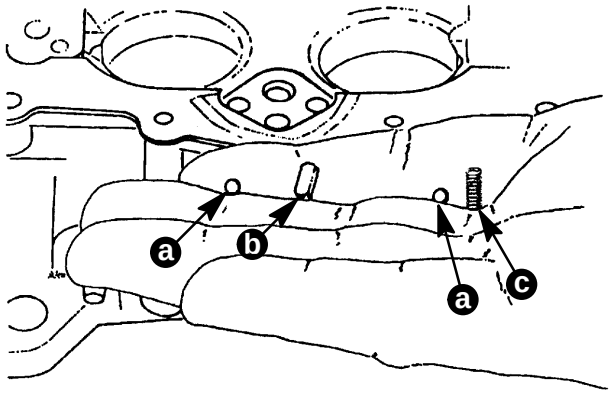
27. Remove check-ball and check-weight, or check-ball and check-spring, from hole beneath pump jet housing.

IMPORTANT: If your carburetor had a ball and weight combination, replace with ball and weight. If your carburetor used a ball and spring combination, replace with ball and spring.



70463

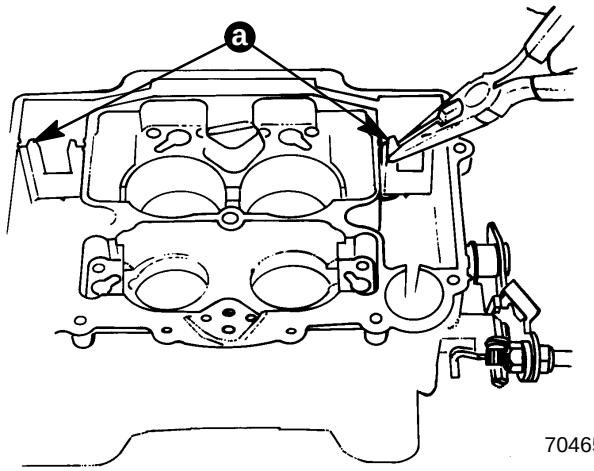
a - Ball Location



70464

a - Check Ball
b - Check Weight
c - Check Spring

28. Remove float bowl baffle plates, if necessary.



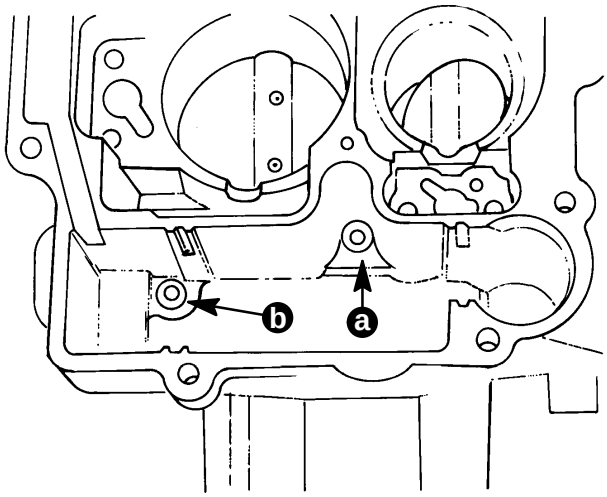
70465

a - Baffle Plate

IMPORTANT: Do not mix up the primary and secondary jets. Make note of the jet sizes and their location before removal to be certain that during reassembly they are installed in the carburetor side from which they were removed.

NOTE:If jets are difficult to remove, place a screwdriver, with the correct width, in the jet slot and lightly tap the end of the screwdriver with a hammer.

29. Remove primary and secondary jets.



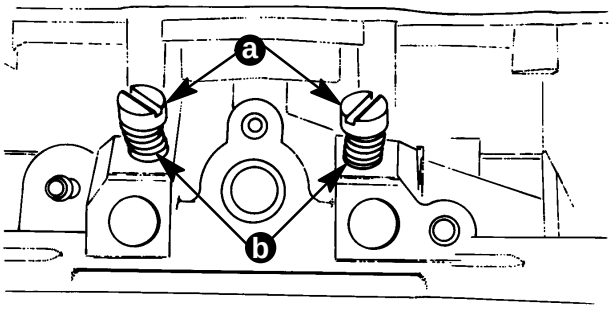
70466

a - Primary Fuel Jet
b - Secondary Fuel Jet

IMPORTANT: Before removing mixture screws, check and note the number of turns from the fully seated position. Also, do not mix up the two screws.

Index

30. Remove mixture screws.



70467

a - Idle Mixture Screw
b - Spring, Idle Mixture Screw

Cleaning and Inspection

⚠CAUTION

Rubber, plastic parts, pump plungers or diaphragms cannot be immersed in carburetor cleaner.

⚠CAUTION

Avoid damage to carburetor. Do not leave carburetor in immersion-type cleaner for more than two hours.

IMPORTANT: Do not immerse metering rod springs in carburetor cleaner; the color, if not "natural" metal, may be removed. Clean separately as needed.

1. Clean metal carburetor parts in a commercial, immersion-type cleaner, until all deposits have been removed. Follow manufacturer's instructions of cleaner being used for proper cleaning and rinsing procedures.

⚠CAUTION

Avoid personal injury. Always wear safety glasses when using compressed air.

2. Blow out passages with compressed air. Do not drill through passages.

IMPORTANT: DO NOT use a wire or drill to clean jets, passages, or tubes in carburetor, as this may enlarge orifices and seriously affect carburetor calibration.

3. Wipe all parts that cannot be cleaned in immersion cleaner with a clean, dry cloth.
4. Carefully inspect all carburetor parts for damage or wear; pay particular attention to the following:
   a. **Idle mixture screws -** Replace if damaged or worn.
   b. **Fuel inlet needle valve and seat -** Replace with new needle and seat if worn or damaged.
   c. **Casting surfaces -** Inspect accelerator pump plunger well for scoring or deposits. Replace worn or corroded components.
   d. **All linkage rods and levers -** Replace if worn or damaged.
   e. **Accelerator pump and plunger parts -** Replace pump and parts if worn or damaged.
   f. **Float assembly and hinge pin -** Float weight of each should be the same. Replace either if fuel can be heard inside when shaken. Check hinge pin and holes for wear. Replace components if worn or defective.
   g. **Throttle valves and shafts -** Check for binding (through entire operating range, making sure valves open and close completely) or for looseness in carburetor body.

IMPORTANT: DO NOT remove throttle valves. If any of the throttle parts or float bowl/carburetor body shaft bores are found to be worn or damaged, carburetor replacement is required.

   h. **Choke valve and shaft/lever assembly -** Check shaft and lever for excessive looseness in air horn. Check choke valve and shaft/lever assembly for binding through entire operating range. Air horn assembly must be replaced if choke valve and shaft/lever are worn.

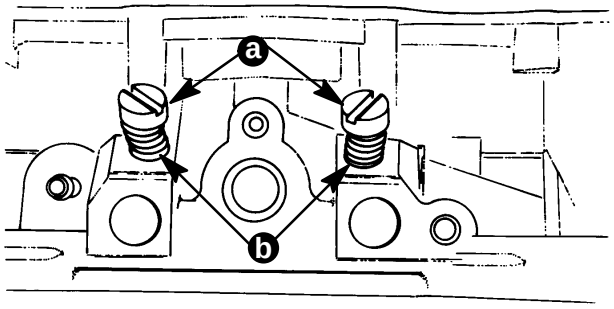
5. Check that choke pull-off diaphragm plunger retracts when vacuum is applied to unit, and that it holds vacuum (plunger remains seated if vacuum is maintained).

Index

Reassembly

1. Install mixture screws (needles) with springs in place. Turn idle mixture screws in (clockwise) until LIGHTLY seated, then back out one and quarter (1-1/4) turns if previous settings were not noted on disassembly.

IMPORTANT: Do not turn idle mixture screws tightly against seat, as damage to seat and/or needle may result.

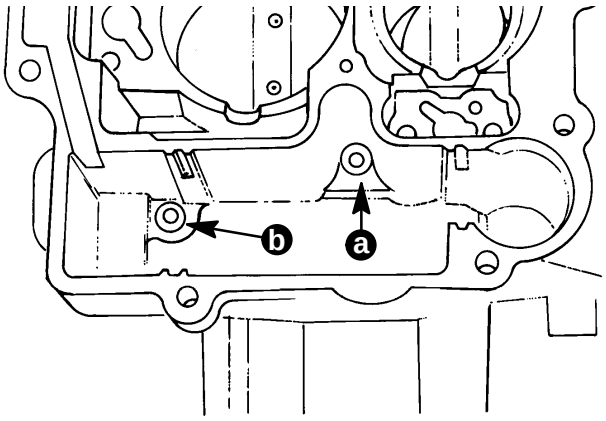


70467

a - Idle Mixture Screw
b - Spring, Idle Mixture Screw

2. Install the primary and secondary jets. Tighten only till snug.

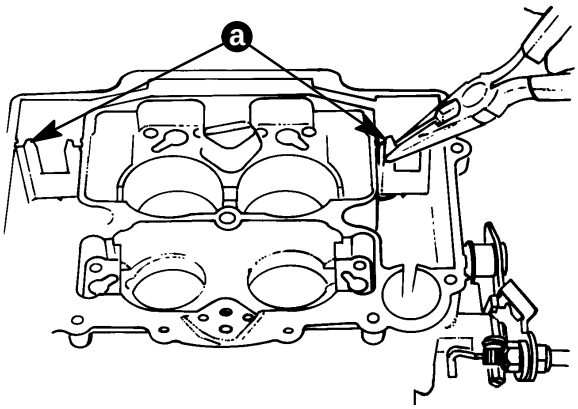
IMPORTANT: Be sure that primary and secondary jets are installed in the appropriate location. Be sure that the size matches the same size recorded during disassembly.



70466

a - Primary Fuel Jet
b - Secondary Fuel Jet

3. Install the float bowl baffle plates, if previously removed.

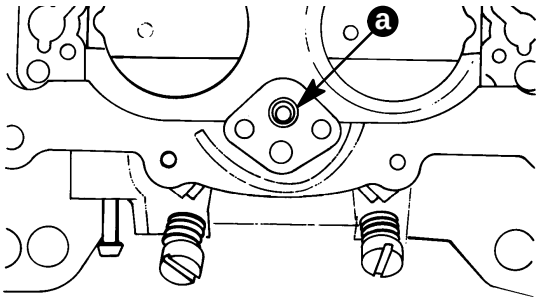


70465

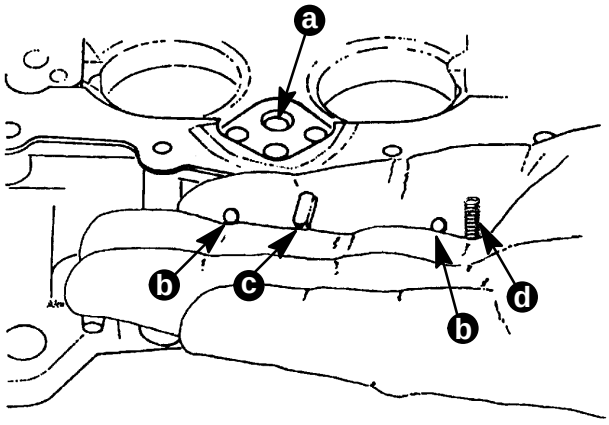
c - Baffle Plate

4. Into bore beneath pump jet housing location, install check-ball and then check-weight or, if so equipped, check-ball and check-spring.

IMPORTANT: If your carburetor had a ball and weight combination, replace with ball and weight. If your carburetor used a ball and spring combination, replace with ball and spring.



70463

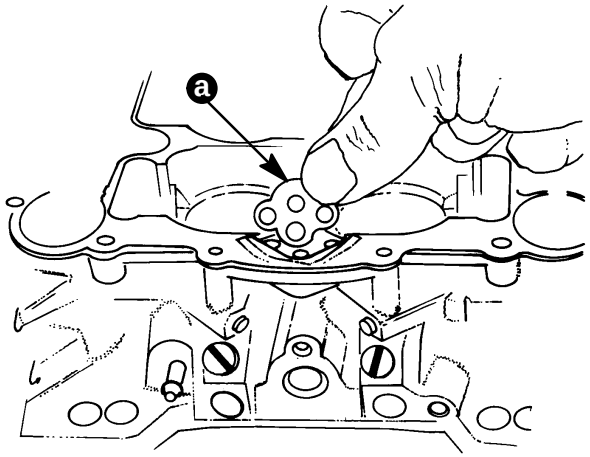


70464

a - Bore
b - Check Ball
c - Check Weight
d - Check Spring

Index

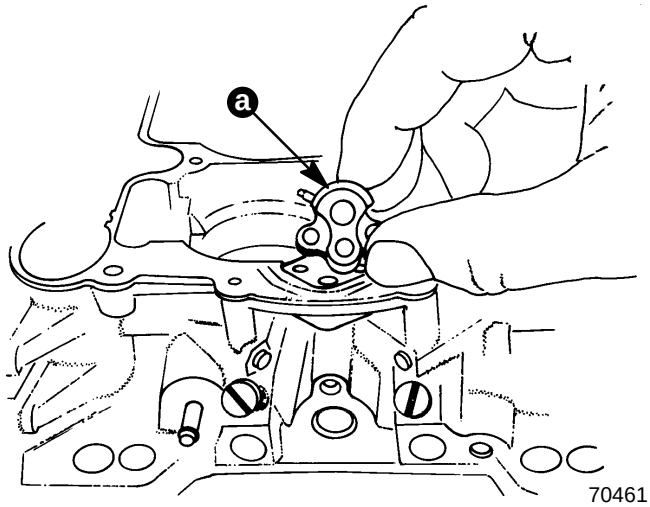
5. Position pump jet housing gasket.



70462

a - Gasket, Pump Jet Housing

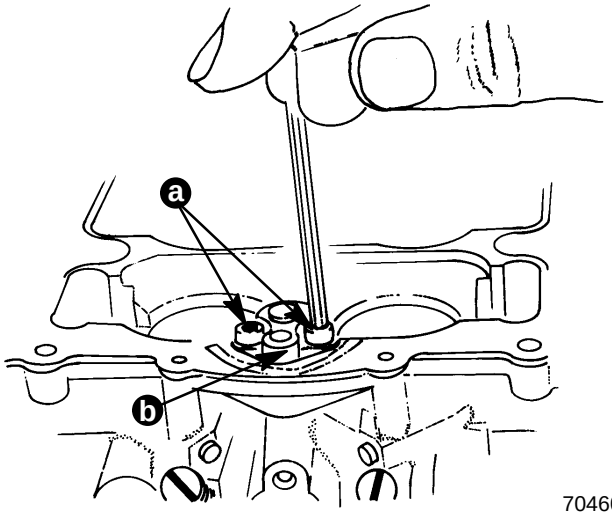
6. Install pump jet housing.



70461

a - Pump Jet Housing

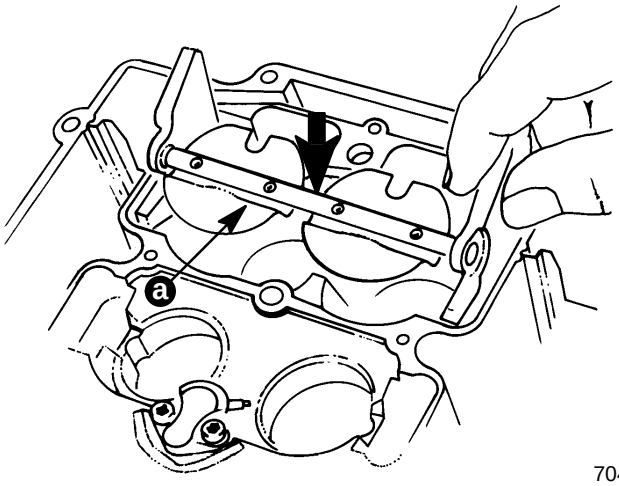
7. Install two screws that secure pump jet housing. Tighten securely.



70460

a - Screws
b - Pump Jet Housing

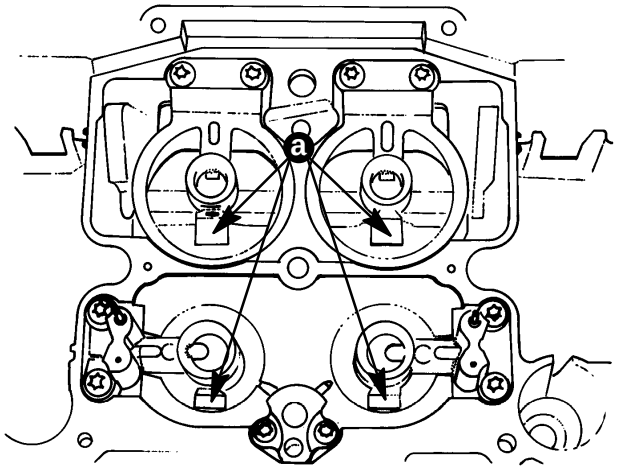
8. Install the secondary air valve and weight assembly.



70459

a - Secondary Air Valve And Weight Assembly

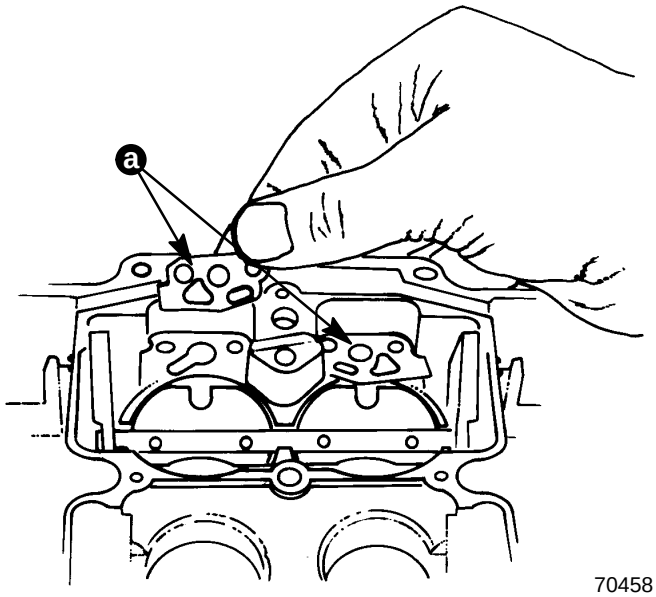
IMPORTANT: Before installing venturi clusters, it is important to note which clusters were equipped with a "distribution tab." This distribution tab arrangement varies from one carburetor to another.



70452

a - Distribution Tab(s) Location And Total Number May Vary

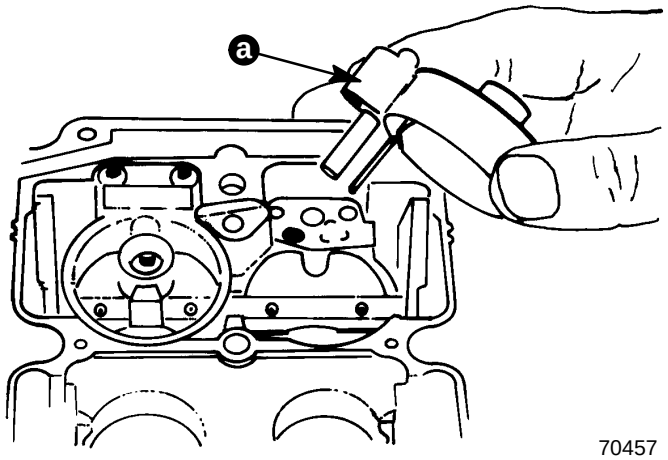
9. Position the secondary venturi cluster gaskets.



70458

a - Gasket, Secondary Venturi Cluster

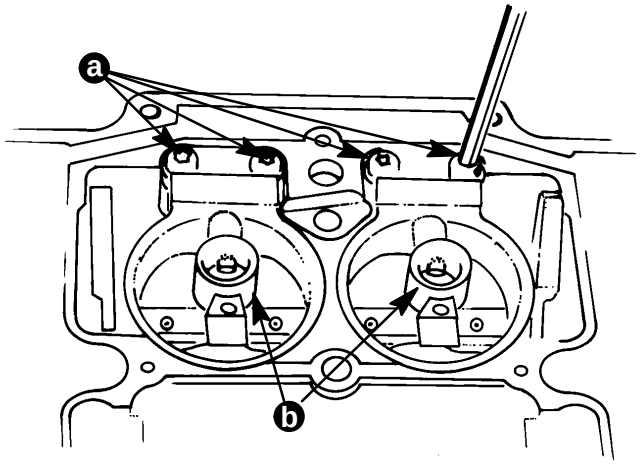
10. Install the secondary venturi clusters.



70457

a - Secondary Venturi Cluster

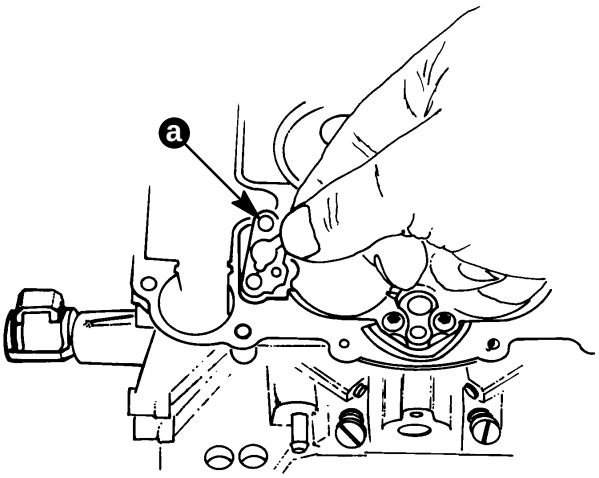
11. Secure each cluster with two screws. Tighten securely.



70456

a - Screws (Two On Each Side)
b - Secondary Venturi Cluster(s)

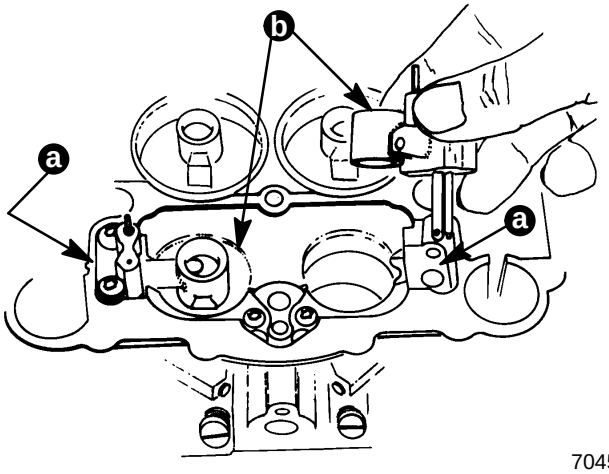
12. Position the primary venturi cluster gaskets.



70455

a - Gasket, Primary Venturi Cluster

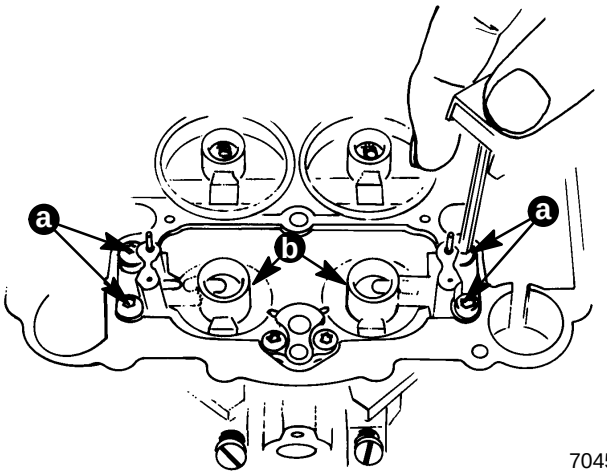
13. Install the primary venturi clusters.



70454

a - Gasket, Primary Venturi Cluster (One Not Visible In This View)
b - Primary Venturi Cluster

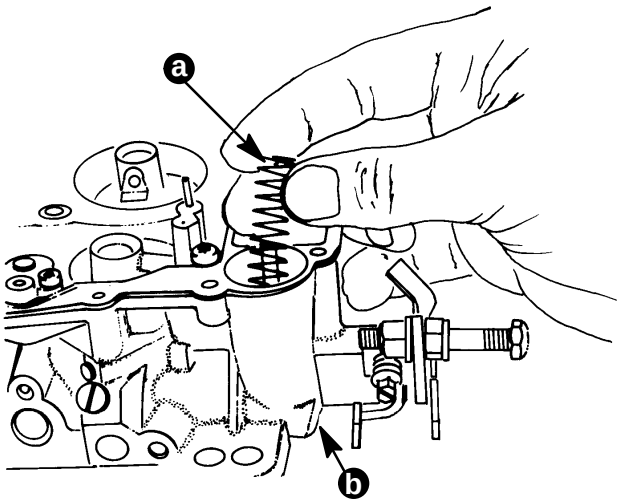
14. Secure each cluster with two screws. Tighten securely.



70453

a - Screws (Two Each Side)
b - Primary Venturi Cluster(s)

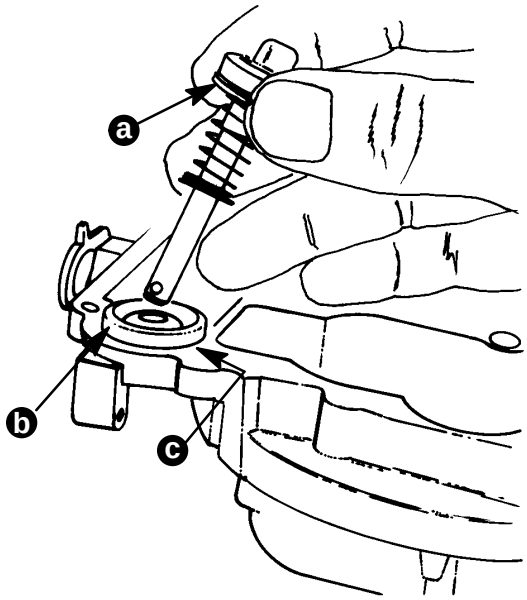
15. Install the accelerator pump spring into bottom half of carburetor.



70451

a - Accelerator Pump Spring
b - Carburetor Bottom

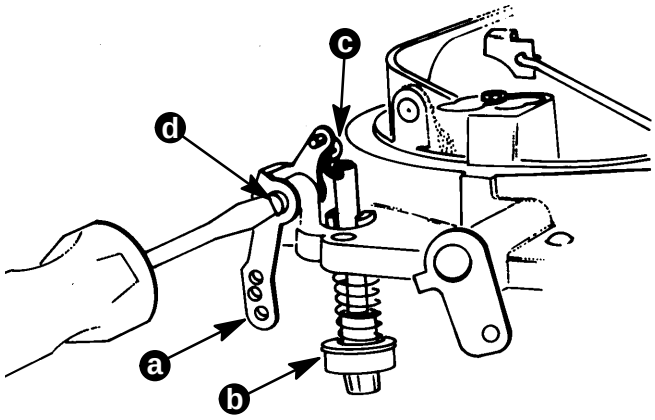
16. Install accelerator pump in top of carburetor housing, after placing washer and guide in position.



70450

a - Accelerator Pump
b - Plunger Guide
c - Plunger Washer (Not Visible In This View)

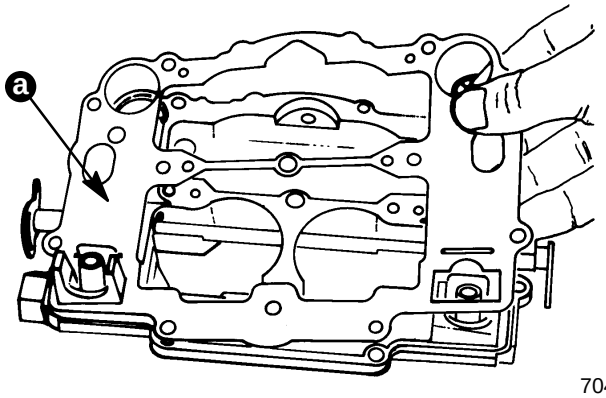
17. Connect accelerator pump lever to pump rod using the S-link. Secure pump lever with pivot screw. Tighten securely. Check to ensure lever actuates the accelerator pump.



70449

a - Accelerator Pump Lever
b - Accelerator Pump
c - S-Link
d - Retainer Screw

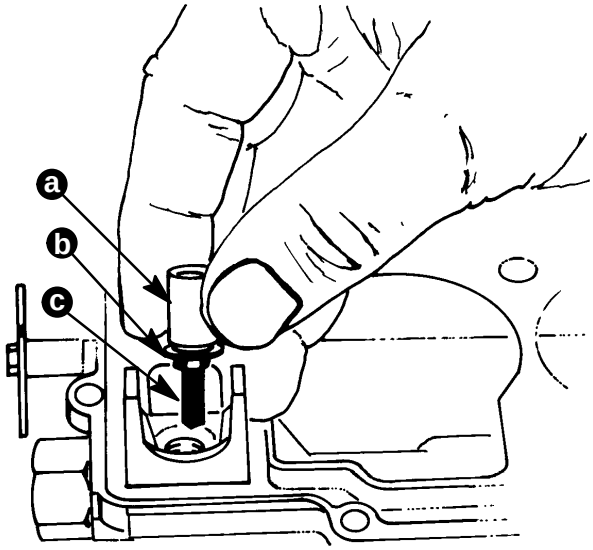
18. Install gasket on top of carburetor.



70448

a - Gasket

19. Install inlet filter in bottom of inlet seat. Install inlet seat with gasket in place. Tighten securely.



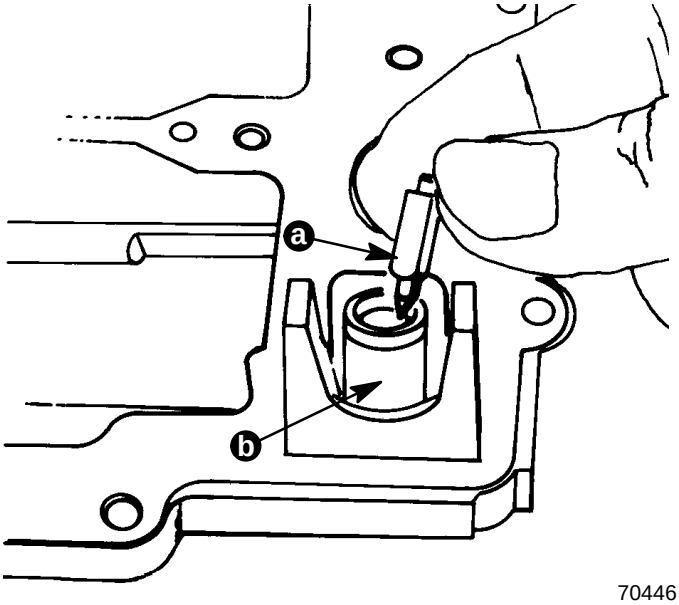
70447

a - Seat
b - Gasket
c - Inlet Filter

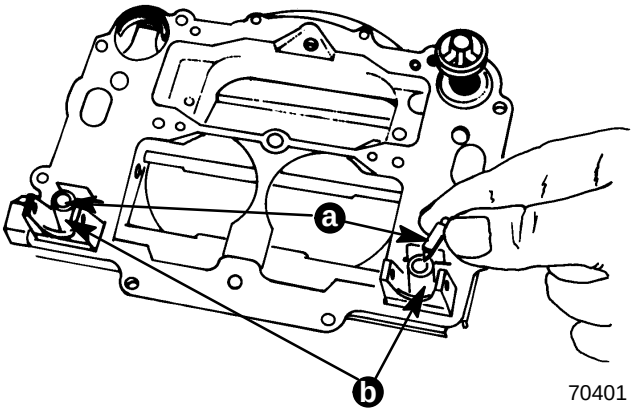
Index

IMPORTANT: If using existing needles and seats, be sure to reinstall them as matched sets, as noted during disassembly.

20. Install appropriate inlet needles into inlet seats.



70446

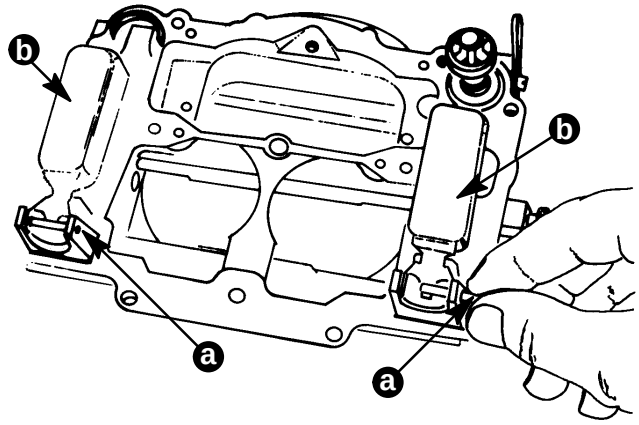


70401

a - Inlet Needle(s)
b - Seat(s)

IMPORTANT: If using existing floats, be sure to re-install them on the same side as removed.

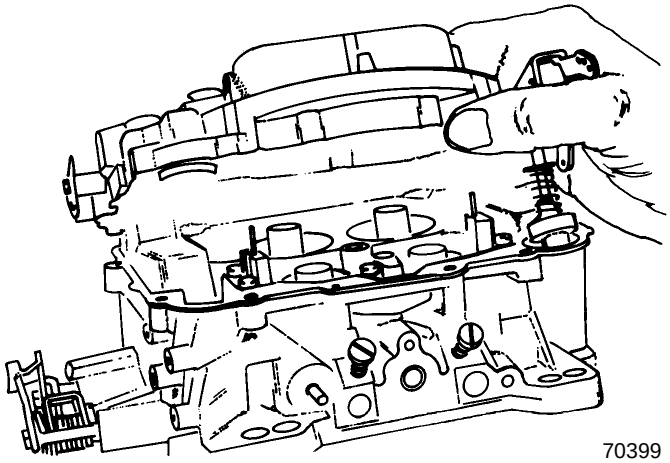
21. Install floats using hinge pins.



70400

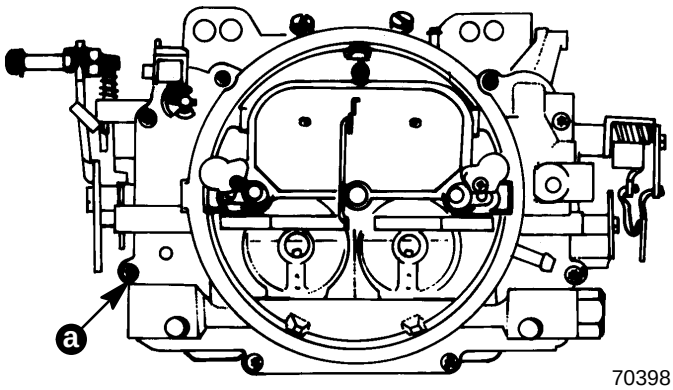
a - Pin(s)
b - Floats(s)

22. Carefully lower top of carburetor onto bottom part.



70399

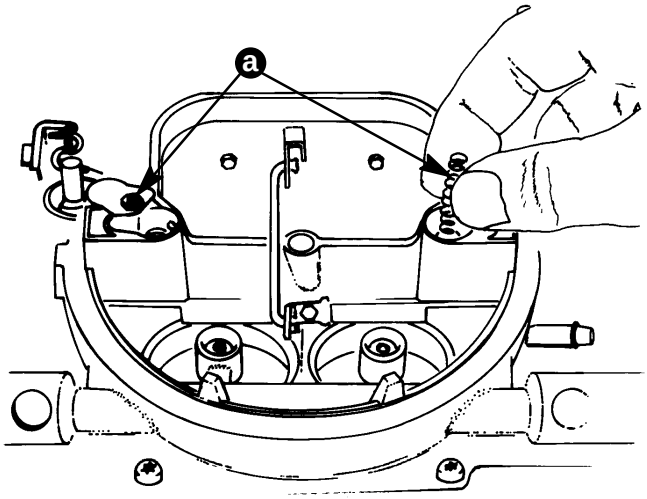
23. Ensure gasket is properly positioned between the two parts and secure the top to bottom with screws (nine total). Tighten securely.



70398

a - Screw(s)

24. Install metering rod springs into each metering rod hole. Be certain to install the appropriate color spring (refer to “Specifications”).

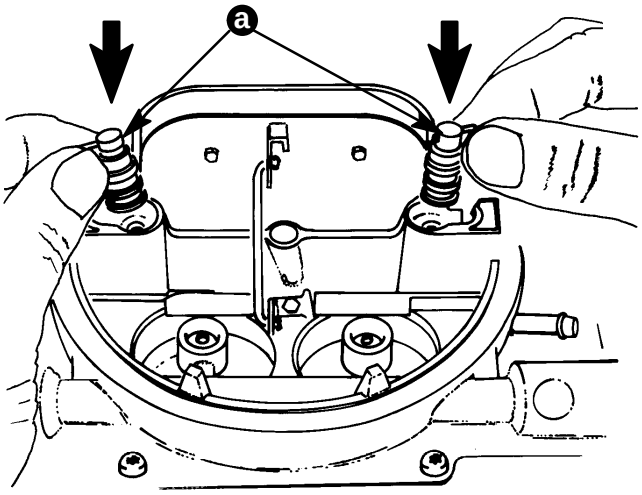


70397

a - Spring(s)

IMPORTANT: If using existing metering rods, be sure that they are reinstalled in the same side from which removed during disassembly.

25. Carefully install metering rod assemblies in the appropriate holes. Push down lightly on metering rods to ensure that plunger will spring up and down.

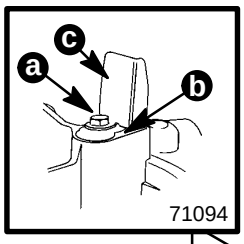


70396

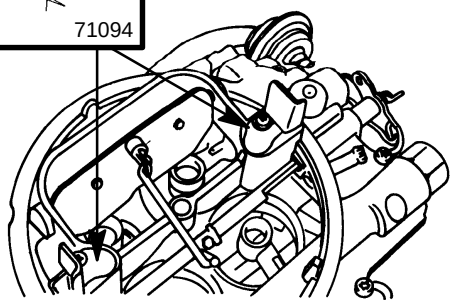
a - Metering Rod Assembly(s)

IMPORTANT: Some carburetors are equipped with air deflectors that are attached to the screw that holds down the metering rod covers. Be sure to reinstall the deflectors if your model carburetor requires them.

26. Position metering rod covers (and air deflectors, if equipped) over metering rods and install screws. Tighten securely.



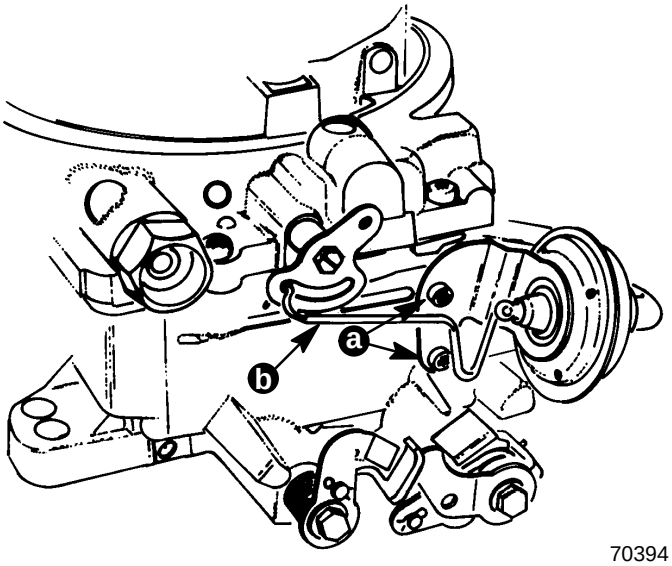
71094



71095

a - Screws
b - Metering Cover(s)
c - Air Deflectors (If Equipped)

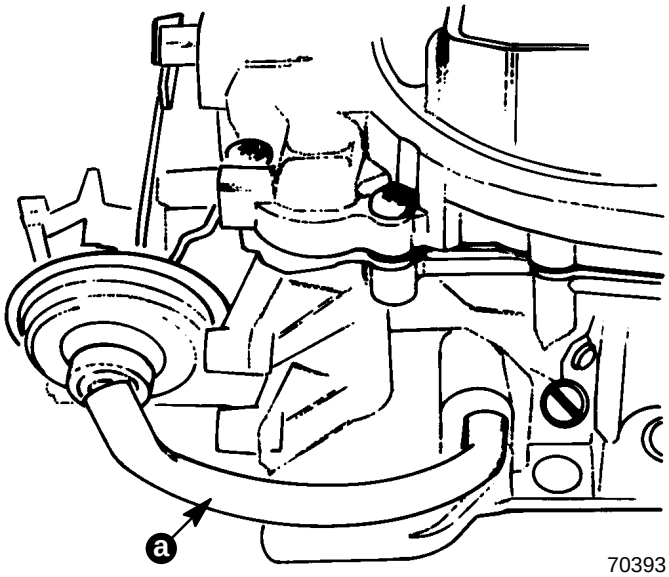
27. Reconnect choke pull-off linkage to carburetor. Reinstall choke pull-off diaphragm. Secure with two screws and tighten securely.



70394

a - Screw(s)
b - linkage Rod

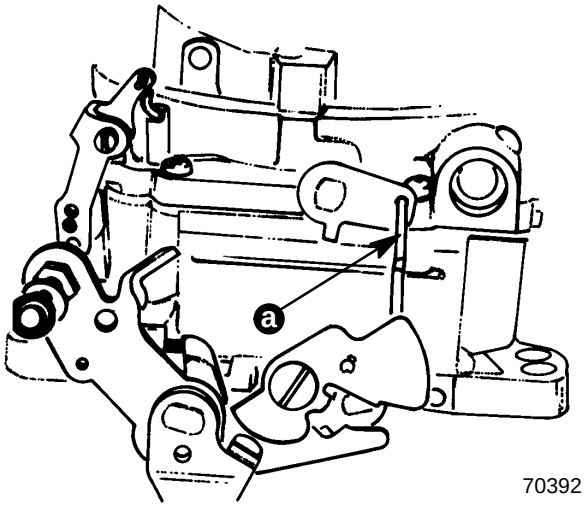
28. Reconnect vacuum hose to choke pull-off diaphragm.



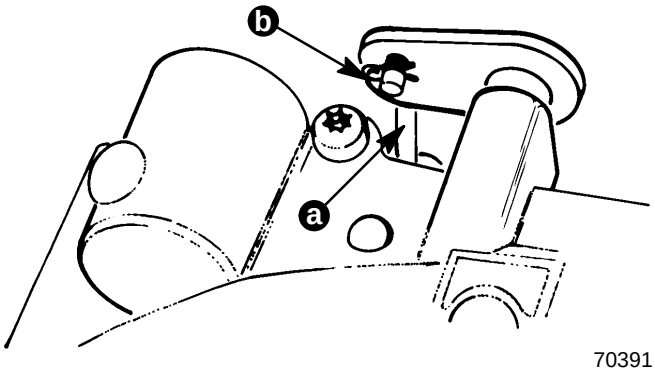
70393

a - Vacuum Hose

29. Reconnect choke plate linkage. Secure with wire clip.



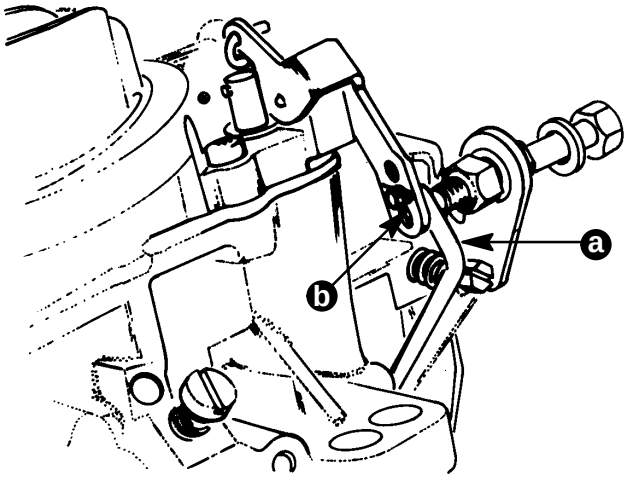
70392



70391

a - Choke Plate Linkage Rod
b - Wire Clip

30. Reconnect accelerator pump linkage rod to hole in accelerator pump lever where originally connected or refer to “Important Service Information” in this section for information regarding adjustment. Accelerator pump linkage adjustment should be checked at this time; refer to Adjustments - “Accelerator Pump” as previously outlined. Secure using wire clip.



70390

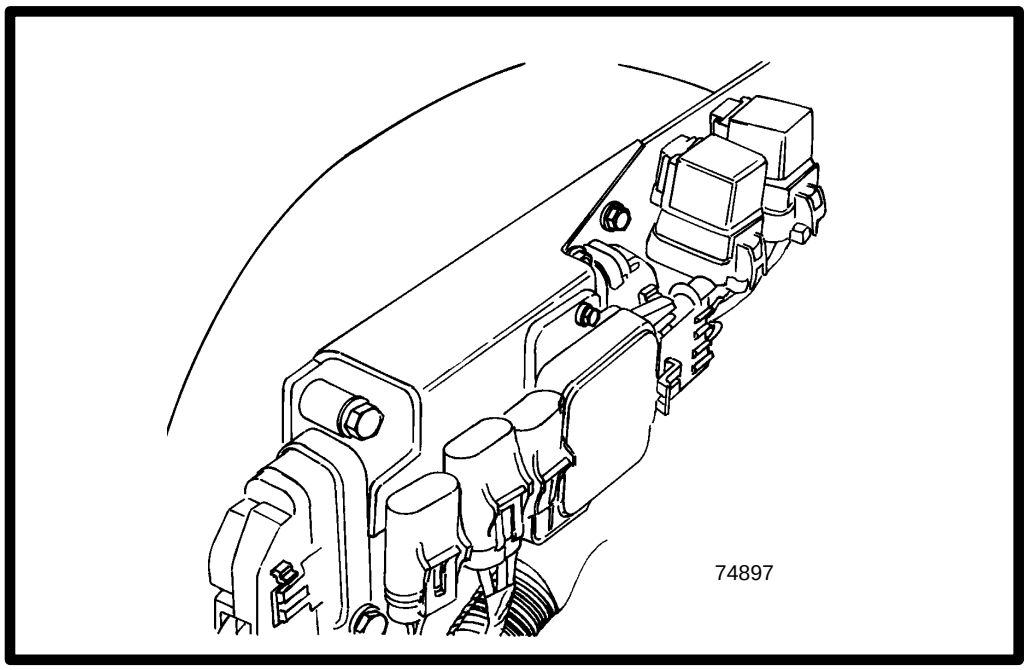
a - Accelerator Pump Linkage Rod
b - Wire Clip

31. Refer to “Installation” and install carburetor.

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

FUEL SYSTEMS



5

D

THROTTLE BODY FUEL INJECTION

Index

Table of Contents

Page

General Information 5D-1
Introduction 5D-1
Visual/Physical Inspection 5D-1
Basic Knowledge and Tools Required 5D-1
Electrostatic Discharge Damage 5D-1
Diagnostic Information 5D-2
Wiring Harness Service 5D-2
Wiring Connector Service 5D-2
Abbreviations 5D-3
Changes In Terminology 5D-4
Diagnostic Trouble Codes 5D-4
ECM Self-Diagnostics 5D-5
Diagnostic Code Tool With Malfunction Indicator Lamp 5D-5
Intermittent Malfunction Indicator Lamp . . . 5D-5
Reading Codes 5D-5
Scan Tools 5D-6
EFI Diagnostic Circuit Check 5D-6
Scan Tool Use with Intermittents 5D-6
Non-Scan Diagnosis of Driveability Concerns (With No Codes Set) 5D-7
Special Tools 5D-8
Service Precautions 5D-9
Electronic Control Module (ECM) and Sensors 5D-10
General Description 5D-10
Computers and Voltage Signals 5D-10
Analog Signals 5D-10
Digital Signals 5D-11
Engine Control Module (ECM) 5D-11
Speed Density System 5D-12
ECM Input and Sensor Descriptions 5D-13
Spark Management 5D-16
High Energy Ignition with Ignition Control (IC) 5D-16
Modes Of Operation 5D-16
Distributor Module Mode 5D-16
ECM Control Mode 5D-16
Base Ignition Timing 5D-16
Results of Incorrect Operation 5D-18
Fuel Metering System 5D-18
General Description 5D-18
Modes of Operation 5D-18
Cool Fuel System 5D-19
Throttle Body Injection Components 5D-21
ECM Connector and Symptom Charts 5D-25
ECM Connector and EFI Symptoms Chart (J-1 Circuits) 5D-26
ECM Connector and EFI Symptoms Chart (J-1 Circuits) 5D-27
ECM Connector and EFI Symptoms Chart (J-2 Circuits) 5D-28
ECM Connector and EFI Symptoms Chart (J-2 Circuits) 5D-29

Page

Throttle Body Injection Wiring Diagram (Chart 1 of 4) 5D-30
Throttle Body Injection Wiring Diagram (Chart 2 Of 4) 5D-31
Throttle Body Injection Wiring Diagram (Chart 3 Of 4) 5D-32
Throttle Body Injection Wiring Diagram (Chart 4 Of 4) 5D-33
Diagnostic Circuit Check 5D-35
Scan Tool Normal Specifications (Idle /Warm Engine/Closed Throttle/Neutral) 5D-35
No “Malfunction Indicator Lamp” (Marine Diagnostic Code Tool Installed) . 5D-38
No DLC Data or Will Not Flash Code 12 “Malfunction Indicator Lamp” On Steady (Marine Diagnostic Code Tool Installed) Chart A-2 (1 of 2) 5D-40
Engine Cranks but Will Not Run Chart A-3 (1 of 4) 5D-42
Fuel System Diagnosis Chart A-7 (1 of 6) 5D-46
EFI System/Ignition Relay Check (1 of 2) 5D-52
Ignition System Check (1 of 2) 5D-54
Ignition System Check (2 of 2) 5D-56
Idle Air Control (IAC) Functional Test (1 of 2) 5D-58
Lanyard Stop Circuit Check (Emergency Stop) Circuit Check (1 of 2) 5D-60
Audio Warning Buzzer Circuit Check (1 of 2) 5D-62
Diagnostics-Without Scan Tool 5D-64
Code 14: Engine Coolant Temperature (ECT) Sensor Circuit (Non-Scan) (1 of 2) 5D-64
Code 21: Throttle Position (TP) Sensor Circuit (Non-Scan) (1 Of 2) 5D-66
Code 33: Manifold Absolute Pressure (MAP) Sensor Circuit (Non-Scan) (1 Of 2) 5D-68
Code 42: Ignition Control (IC) Circuit (Non-Scan) (1 of 2) 5D-70
Code 43: Knock Sensor (KS) (Non-Scan) (1 of 2) 5D-72
Code 51: Calibration Memory Failure (Non-Scan) (1 of 2) 5D-74
Diagnostics - Using Scan Tool (Scan) 5D-76
Code 14 Engine Coolant Temperature (ECT) Sensor Circuit (Scan) (1 of 2) 5D-76
Code 21: Throttle Position (TP) Sensor Circuit (Scan) (1 of 2) 5D-78
Code 33: Manifold Absolute Pressure (MAP) Sensor Circuit (Scan) (1 of 2) 5D-80
Code 42: Ignition Control (IC) Circuit (Scan) (1 Of 2) 5D-82

Index

Page

Code 43: Knock Sensor (KS) (Scan) (1 Of 2) 5D-84
Code 51: Calibration Memory Failure (Scan) (1 Of 2) 5D-86
Troubleshooting 5D-88
Changes In Terminology 5D-88
Diagnostic Trouble Codes 5D-88
Important Preliminary Checks 5D-88
Troubleshooting Charts 5D-89
Fuel Delivery Systems 5D-110
Cool Fuel System Exploded View 5D-110
Vapor Separator Tank (VST) Exploded View 5D-112
Torque Sequence For VST 5D-113
VST Fuel Pump (Exploded View) 5D-114
Vapor Separator Tank (VST) 5D-116
Float and Needle Assembly 5D-117
Diaphragm Assembly 5D-118
Repair Procedures 5D-120
Special Tools 5D-120
Lubricants/Sealants/ Adhesives 5D-120
Torque Specifications 5D-120
Throttle Body Injection System Description 5D-121
Service Precautions 5D-121

Page

Throttle Body Exploded Views 5D-122
Induction System 5D-122
Throttle Body 5D-123
Fuel Pressure Relief Procedure 5D-124
Fuel Meter Cover Assembly 5D-124
Fuel Injectors 5D-125
Throttle Body 5D-126
Throttle Body Adapter Plate 5D-127
Throttle Body Injection Sensor and Module Servicing 5D-128
Precautions 5D-128
Electronic Control Module (ECM) 5D-128
Knock Sensor (KS) Module 5D-129
Engine Coolant Temperature (ECT) Sensor 5D-129
Manifold Absolute Pressure (MAP) Sensor 5D-130
Idle Air Control (IAC) Valve 5D-131
Knock Sensor 5D-132
Fuel Pump Relay 5D-135
Ignition Control (IC) System Components 5D-135
Precautions 5D-135
Ignition Coil 5D-136
Spark Plug Replacement 5D-137

THIS PAGE IS INTENTIONALLY BLANK

General Information

⚠ CAUTION

To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed: proper service and repair are important to the safety of the service technician and the safe, reliable operation of all MerCruiser Electronic Fuel Injection equipped engines. If part replacement is necessary, the part must be replaced with one of the same part number or with an equivalent part. Do not use a replacement part of lesser quality. The service procedures recommended and described in this service manual are effective methods of performing service and repair. Some of these procedures require the use of tools specially designed for the purpose. Accordingly, anyone who intends to use a replacement part, service procedure or tool, which is not recommended by the system manufacturer, must first determine that neither his safety nor the safe operation of the engine will be jeopardized by the replacement part, service procedure or tool selected. It is important to note that this manual contains various "Cautions" and "Notes" that must be carefully observed in order to reduce the risk of personal injury during service or repair, or the possibility that improper service or repair may damage the engine or render it unsafe. It is also important to understand that these "Cautions" and "Notes" are not exhaustive, because it is impossible to warn of all the possible hazardous consequences that might result from failure to follow these instructions.

Introduction

The following manual has been prepared for effective diagnosis of the MerCruiser Electronic Fuel Injection system.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication approval. The right is reserved to make changes at any time without notice.

An understanding of the material contained herein and in subsequent publications issued when necessary, will assist service personnel in properly maintaining the quality to which MerCruiser engine control systems are built.

Visual/Physical Inspection

A careful visual and physical inspection must be performed as part of any diagnostic procedure. This can often lead to fixing a problem without further steps. Inspect all vacuum hoses for correct routing, pinches, cuts, or disconnects. Be sure to inspect hoses that are difficult to see. Inspect all the wires in the engine compartment for proper connections, burned or chafed spots, pinched wires, or contact with sharp edges or hot exhaust manifolds. This visual/physical inspection is very important. It must be done carefully and thoroughly.

Basic Knowledge and Tools Required

To use this manual most effectively, a general understanding of basic electrical circuits and circuit testing tools is required. You should be familiar with wiring diagrams; the meaning of volts, ohms and amperes; the basic theories of electricity; and understand what happens in an open or shorted wire. To perform system diagnosis, several special tools and equipment are required. Please become acquainted with the tools and their use before attempting to diagnose the system. Special tools which are required for system service are listed later in this section (see "Table of Contents").

Electrostatic Discharge Damage

Electronic components used in control systems are often designed to carry very low voltage, and are very susceptible to damage caused by electrostatic discharge. It is possible for less than 100 volts of static electricity to cause damage to some electronic components. By comparison, it takes 4,000 volts for a person to even feel the effect of a static discharge.

There are several ways for a person to become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a seat, in which a charge of as much as 25,000 volts can build up. Charging by induction occurs when a person with well-insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges of either type can cause damage; therefore, it is important to use care when handling and testing electronic components.

Index

Diagnostic Information

The diagnostic charts and functional checks in this manual are designed to locate a faulty circuit or component through logic based on the process of elimination. **The charts are prepared with the requirement that the system functioned correctly at the time of assembly and that there are no multiple failures.**

Wiring Harness Service

Marine engine control circuits contain many special design features not found in standard land vehicle wiring. Environmental protection is used extensively to protect electrical contacts and proper splicing methods must be used when necessary.

The proper operation of low amperage input/output circuits depends upon good continuity between circuit connectors. It is important before component replacement and/or during normal troubleshooting procedures that a visual inspection of any questionable mating connector is performed. Mating surfaces should be properly formed, clean and likely to make proper contact. Some typical causes of connector problems are listed below.

1. Improperly formed contacts and/or connector housing.
2. Damaged contacts or housing due to improper engagement.
3. Corrosion, sealer or other contaminants on the contact mating surfaces.
4. Incomplete mating of the connector halves during initial assembly or during subsequent troubleshooting procedures.
5. Tendency for connectors to come apart due to vibration and/or temperature cycling.
6. Terminals not fully seated in the connector body.
7. Inadequate terminal crimps to the wire.

Wire harnesses should be replaced with proper part number harnesses. When signal wires are spliced into a harness, use the same gauge wire with high temperature insulation only.

With the low current and voltage levels found in the system, it is important that the best possible bond be made at all wire splices by soldering the splices, as shown in the following illustrations. Use care when probing a connector or replacing connector terminals. It is possible to short between opposite terminals. If this happens, certain components can be damaged. Always use jumper wires with the corresponding mating terminals between connectors for circuit checking. **NEVER** probe through connector seals, wire insulation, secondary ignition wires, boots, nipples or covers.

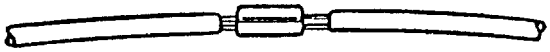
Microscopic damage or holes will result in eventual water intrusion, corrosion and/or component or circuit failure.

WIRE REPAIR

1. Locate damaged wire.
2. Remove insulation as required.

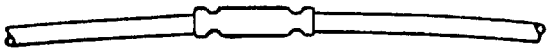
73048

3. Splice two wires together using splice clips and rosin core solder.



73048

4. Cover splice with heat shrink sleeve to insulate from other wires.



73048

Wiring Connector Service

Most connectors in the engine compartment are protected against moisture and dirt which could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels found in the electronic system. The connectors have a lock which secures the male and female terminals together. A secondary lock holds the seal and terminal into the connector.

When diagnosing, open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor or in the wiring harness may locate the open circuit condition. This should always be considered when an open circuit or failed sensor is indicated. Intermittent problems may also be caused by oxidized or loose connections.

Before making a connector repair, be certain of the type of connector. Some connectors look similar but are serviced differently. Replacement connectors and terminals are listed in the Parts Catalog.

Ensure that the connector seals are not deformed or crushed when mating the connectors to

Index

Abbreviations

BARO	Barometric Pressure
BAT	Battery Positive Terminal, Battery or System Voltage
B+	Battery Positive
CKT	Circuit
CONN	Connector
CYL	Cylinder
DEG	Degrees
DIAG	Diagnostic
DIST	Distributor
DLC	Data Link Connector
DTC	Diagnostic Trouble Code
DVOM	Digital Volt Ohm Meter
ECM	Engine Control Module
ECT	Engine Coolant Temperature
EEPROM	Electronic Erasable Programmable Read Only Memory
HEI	High Energy Ignition
EMI	Electromagnetic Interference
ENG	Engine
GND	Ground
GPH	Gallons Per Hour
IAC	Idle Air Control
IAT	Intake Air Temperature
IC	Ignition Control

IGN	Ignition
INJ	Injection
kPa	Kilopascal
KS	Knock Sensor System
KV	Kilovolts
MAP	Manifold Absolute Pressure
MIL	Malfunction Indicator Lamp
mSec	Millisecond
N/C	Normally Closed
N/O	Normally Open
PROM	Programmable Read Only Memory
RAM	Random Access Memory
REF HI	Reference High
REF LO	Reference Low
ROM	Read Only Memory
SLV	Slave
SW	Switch
TACH	Tachometer
TERM	Terminal
TP	Throttle Position
V	Volts
VAC	Vacuum
WOT	Wide Open Throttle
in-hg	Inches Of Mercury

Changes In Terminology

Due to industry standardization of terminology for certain electronic engine controls some names and abbreviations have changed.

From	To
(CTS) Coolant Temperature Sensor	(ECT) Engine Coolant Temperature
(TPS) Throttle Position Sensor	(TP) Throttle Position
(EST) Electronic Spark Timing	(IC) Ignition Control
(ESC) Electronic Spark Control	(KS) Knock Sensor
(ALDL) Assembly Line Data Link	(DLC) Data Link Connector

Diagnostic Trouble Codes

Code Number	Code Description
Code 12	Ignition On - Engine Not Running
Code 14	(ECT) Engine Coolant Temperature
Code 21	(TP) Throttle Position Sensor
Code 33	(MAP) Manifold Absolute Pressure
Code 42	(IC) Ignition Control
Code 43	(KS) Knock Sensor
Code 51	Calibration Memory Failure

ECM Self-Diagnostics

The ECM performs a continual self-diagnosis on certain control functions. This diagnostic capability is complemented by the diagnostic procedures contained in this manual. The ECM's language for communicating the source of a malfunction is a system of diagnostic codes. The codes are two digit numbers that can range from 12 to 51. When a malfunction is detected by the ECM, a code is set and the Malfunction Indicator Lamp is illuminated.

Diagnostic Code Tool With Malfunction Indicator Lamp

There are various manufacturers of Diagnostic Code Tools. Most Tools are equipped with a Malfunction Indicator Lamp (MIL).

- It informs the service technician that a problem has occurred and that the vessel is in need of service as soon as reasonably possible.
- It displays Codes stored by the ECM which help the technician diagnose system problems.

As a bulb and system check, the lamp will come ON with the key on and the engine not running. When the engine is started, the light will turn OFF. If the lamp remains ON, the self-diagnostic system has detected a problem. If the problem goes away, the light will go out in most cases after ten seconds, but a code will remain stored in the ECM.

When the lamp remains ON while the engine is running, or when a malfunction is suspected due to a driveability problem, "EFI Diagnostic Circuit Check" must be performed. These checks will expose malfunctions which may not be detected if other diagnostics are performed prematurely.

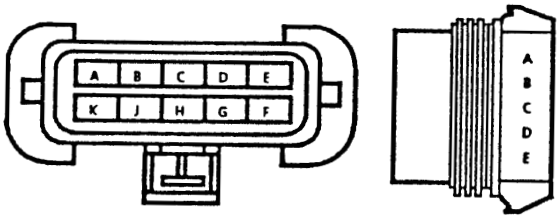
Intermittent Malfunction Indicator Lamp

In the case of an intermittent problem, the Malfunction Indicator Lamp will light for ten seconds and then will go out. However, the corresponding code will be stored in the memory of the ECM. When unexpected codes appear during the code reading process, one can assume that these codes were set by an intermittent malfunction and could be helpful in diagnosing the system.

An intermittent code may or may not reset. IF IT IS AN INTERMITTENT FAILURE, A DIAGNOSTIC CODE CHART IS NOT USED. Consult the "Diagnostic Aids" on the same page as the diagnostic code chart. "Troubleshooting" also covers the topic of "Intermittents." A physical inspection of the applicable sub-system most often will resolve the problem.

Reading Codes

The provision for communicating with the ECM is the Data Link Connector (DLC) connector. It is part of the EFI engine wiring harness, and is a 10-pin connector, which is electrically connected to the ECM. It is used in the assembly plant to receive information in checking that the engine is operating properly before it leaves the plant. The code(s) stored in the ECM's memory can be read either through a scan tool, (a diagnostic scanner that plugs into the DLC connector), or by counting the number of flashes of the Malfunction Indicator Lamp when the diagnostic code tool is installed and SERVICE mode is selected.



73053

DLC Connector

Once the diagnostic code tool has been connected, the ignition switch must be moved to the ON position, with the engine not running. At this point, the Malfunction Indicator Lamp should flash Code 12 three times consecutively. This would be the following flash sequence: flash, pause, flash-flash, long pause, flash, pause, flash-flash, long pause, flash, pause, flash-flash. Code 12 indicates that the ECM's diagnostic system is operating. If Code 12 is not indicated, a problem is present within the diagnostic system itself, and should be addressed by consulting the appropriate diagnostic chart in "Diagnostics."

Following the output of Code 12, the Malfunction Indicator Lamp will indicate a diagnostic code three times if a code is present, or it will simply continue to output Code 12. If more than one diagnostic code has been stored in the ECM's memory, the codes will be output from the lowest to the highest, with each code being displayed three times.

Index

If a scan tool is used to read the codes, follow the manufacturer's instructions.

SERVICE MODE

When the diagnostic code tool is installed at the Data Link Connector (DLC) and the selector switch is set at SERVICE, the system will enter what is called the SERVICE mode. In this mode the ECM will:

1. Display a Code 12 by flashing the Malfunction Indicator Lamp (indicating the system is operating correctly).
2. Display any stored codes by flashing the Malfunction Indicator Lamp. Each code will be flashed three times, then Code 12 will be flashed again.
3. The IAC valve moves to its fully extended position, blocking the idle air passage. This is important to remember, as an attempt to run the vessel while in SERVICE mode will most likely result in an abnormally low idle speed or a stalled engine.
4. Holds ignition advance steady.

NORMAL MODE

Engines can be monitored in the normal mode. Certain parameters can be observed without changing the engine operating characteristics.

Scan Tools

The ECM can communicate a variety of information through the DLC connector. This data is transmitted at a high frequency which requires a scan tool for interpretation.

With an understanding of the data which the tool displays, and knowledge of the circuits involved, the tool can be very useful in obtaining information which would be more difficult or impossible to obtain with other equipment.

Scan tools do not make the use of diagnostic charts unnecessary, nor can they indicate exactly where a problem is in a particular circuit. Tree charts incorporate diagnosis procedures using a scan tool where possible or a Diagnostic Code Tool (non-scan) if a scan tool is unavailable.

EFI Diagnostic Circuit Check

After the visual/physical inspection, the EFI Diagnostic Circuit Check is the starting point for all diagnostic procedures. Refer to EFI Diagnostic Circuit Check.

The correct procedure to diagnose a problem is to follow two basic steps.

1. Are the on-board diagnostics working? This is determined by performing the EFI Diagnostic Circuit Check. Since this is the starting point for the diagnostic procedures, always begin here. If the on-board diagnostics are not working, the EFI Diagnostic Circuit Check will lead to a diagnostic chart in "Diagnostics" to correct the problem. If the on-board diagnostics are working correctly, go to step 2.
2. If there is a code stored: If a code is stored, go directly to the numbered code chart in "Diagnostics." This will determine if the fault is still present.

Scan Tool Use with Intermittents

The scan tool allows manipulation of wiring harnesses or components with the engine not running, while observing the scan tool readout.

The scan tool can be plugged in and observed while running the vessel under the condition when the Malfunction Indicator Lamp turns ON momentarily or when the engine driveability is momentarily poor. If the problem seems to be related to certain parameters that can be checked on the scan tool, they should be checked while running the vessel. If there does not seem to be any correlation between the problem and any specific circuit, the scan tool can be checked on each position, watching for a period of time to see if there is any change in the readings that indicates intermittent operation.

The scan tool is also an easy way to compare the operating parameters of a poorly operating engine with those of a known good one. For example, a sensor may shift in value but not set a trouble code. Comparing the senor's readings with those of the typical scan tool data readings may uncover the problem.

The scan tool has the ability to save time in diagnosis and prevent the replacement of good parts. The key to using the scan tool successfully for diagnosis lies in the technician's ability to understand the system he is trying to diagnose as well as an understanding of the scan tool operation and limitations. The technician should read the tool manufacturer's operating manual to become familiar with the tool's operation.

CLEARING CODES USING DIAGNOSTIC CODE TOOL (NON-SCAN)

1. Install diagnostic code tool.
2. Turn key ON.
3. Select service mode on code tool.
4. To clear codes, move the throttle, while in neutral, from 0% to 100% then back to 0%.
5. Exit “Service Mode” on code tool.
6. Start engine and let run for fifteen seconds.
7. Turn key OFF for 5 seconds.
8. Select “Service Mode” on code tool.
9. Turn key ON and read codes. If codes are still present, check note following and repeat from Step 1.
10. Refer to appropriate Troubleshooting and/or Diagnostic Charts

A poorly charged battery or engine cranking problem may result in an ECM “reset” and may not allow stored trouble codes to be cleared from EEPROM memory. If this condition exists, BE SURE the battery is fully charged.

NOTE: If a low battery condition does exists the audio warning buzzer will come on for 2 seconds after engine start-up.

CLEARING CODES USING SCAN TOOL (SCAN)

1. Connect scan tool.
2. Start engine.
3. Select clear codes function.
4. Clear codes.
5. Turn key OFF.
6. Turn key ON and read codes. If codes are still present, (there is a real fault in system) check following note and repeat Step 1.

NOTE: *When clearing codes without the use of a scan tool, the battery must be fully charged. The ability to clear codes is directly dependent on the battery being fully charged and able to start the engine with adequate cranking RPM.*

Non-Scan Diagnosis of Driveability Concerns (With No Codes Set)

If a driveability concern still exists after following the diagnostic circuit check and reviewing “Troubleshooting,” an out-of-range sensor may be suspected. Because of the unique design of the EFI system, fail-safes have been incorporated into the ECM to replace a sensed value with a default value in the case of a sensor malfunction or sensor wiring concern. By allowing this to occur, limited engine performance is restored until the vessel is repaired. A basic understanding of sensor operation is necessary in order to diagnose an out-of-range sensor.

If the sensor is within its working or acceptable parameters, as shown, the ECM does not detect a problem. If the sensor should happen to fall out of this “window,” a code will be stored. A known default value will replace the sensed value to restore engine performance.

If the sensor is out of range, but still within the operating window of the ECM, the problem will go undetected by the ECM and may result in trouble later.

A good example of this would be if the coolant sensor was reading incorrectly and indicating to the ECM that coolant temperature was at 20° F, but actual coolant temperature was 175° F. This would cause the ECM to deliver more fuel than was actually needed and result in an overly rich, rough running condition. This condition would not have caused a code to set as the ECM interprets this as within its range.

To identify a sensor which is out of range, unplug it while running the engine. After approximately two minutes, the diagnostic code for that sensor will set, a code, and replace the sensed value with a default value. If at that point a noticeable performance increase is observed, the non-scan code chart for that particular sensor should be followed to correct the problem.

NOTE: *Be sure to clear each code after disconnecting and reconnecting each sensor. Failure to do so may result in a misdiagnosis of the problem.*

Special Tools

Part Number	Tool Name	Description
J-34029-A(Note 1)	High Impedance Multi-meter (DVM)	Minimum 10 megohm input impedance required on all voltage ranges. As ammeter, accurately measures low value current flow. As ohmmeter, reads 0-200 ohms, 2/20/200 kΩ, 2/20 mΩ
J-23738	Vacuum Pump with Gauge - 20 In. Hg Minimum	Gauge monitors manifold engine vacuum. Hand pump used to check fuel pressure regulator
J-34142-B (Note 2)	Unpowered Test Light	Used to check circuit wiring, short to ground, or voltage.
91-99379	Timing Light	Used to check ignition timing. Must have inductive signal pickup.
91-16850A-1	Fuel Pressure Gauge	Used to check fuel system pressure.
J-34730-2A	Injector Harness Test Light	Visually indicates injector electrical impulses from the ECM.
91-823686A2	Quicksilver Scan Tool	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system.
84-822560A2	MERCRUISER Cable	
91-822608--1	MERCRUISER Cartridge	
94040M	EFI Scan Tool/Injector Tester (Rinda Technologies)	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system. Allows for test firing injectors.
94008	Diagnostic Code Tool (Rinda Technologies)	Flashes light to display problem codes
J-35616	Harness Test Adapter	Allows multi-meter connections with wiring harness.
91-805918	Fuel Shut Off Tool	Used to perform fuel system pressure tests
91-805747A1	Timing Tool Jumper Plug	Used to set Ignition timing. Plug connects to DLC
91-806901	Fuel Line Connector	Allows connection of Fuel Pressure Gauge

NOTE 1: The High Impedance Multimeter that comes with the existing Outboard EFI Tester (91-11001A1) meets the requirements listed above.

NOTE 2: Using a test light with 100 mA or less rating may show a faint glow when test actually states no light.

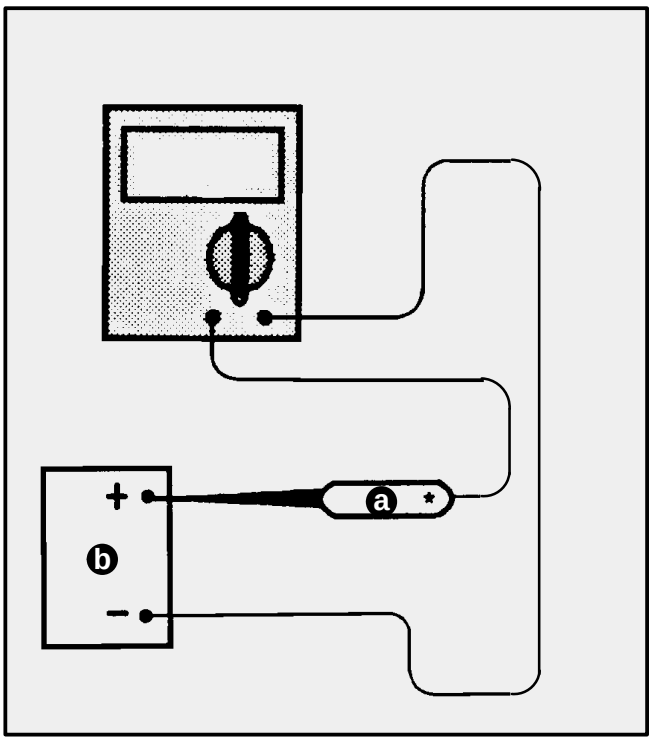
Kent-Moore Tools, Inc.
29784 Little Mack
Roseville, MI 48066
Phone: 800-345-2233

Rinda Technologies
4563 N. Elston Ave.
Chicago, IL 60630
Phone: 312-736-6633

Service Precautions

The following requirements must be observed:

1. Before removing any ECM system component, disconnect the negative battery cable.
2. Never start the engine without the battery being solidly connected.
3. Never separate the battery from the on-board electrical system while the engine is running.
4. Never separate the battery feed wire from the charging system while the engine is running.
5. When charging the battery, disconnect it from the boat's electrical system.
6. Ensure that all cable harnesses are connected solidly and that battery connections are thoroughly clean.
7. Never connect or disconnect the wiring harness at the ECM when the ignition is switched ON.
8. Before attempting any electric arc welding, disconnect the battery leads and the ECM connector(s).
9. When steam cleaning engines, do not direct the steam cleaning nozzle at ECM system components. If this happens, corrosion of the terminals or damage of components can take place.
10. Use only the test equipment specified in the diagnostic charts, since other test equipment may either give incorrect results or damage good components.
11. All voltage measurements using a voltmeter require a digital voltmeter with a rating of 10 megohms input impedance.
12. When a test light is specified, a "low-power" test light must be used. DO NOT use a high-wattage test light. While a particular brand of test light is not suggested, a simple test, as shown below, on any test light will ensure it to be safe for system circuit testing. Connect an accurate ammeter (such as the high impedance digital multimeter) in series with the test light being tested, and power the test light ammeter circuit with the vehicle battery.



a - Test Light
b - Battery

IMPORTANT: If the ammeter indicates **LESS** than 3/10 amp. current flow (.3 A or 300 mA), the test light is SAFE to use.
If the ammeter indicates **MORE** than 3/10 amp. current flow (.3 A or 300 mA), the test light is NOT SAFE to use.

NOTE: *Using a test light with 100 mA or less rating may show a faint glow when test actually states no light.*

13. When using a DVOM to perform voltage measurements, turn the ignition OFF when connecting the DVOM to the circuitry to be tested.

Electronic Control Module (ECM) and Sensors

General Description

The MerCruiser Electronic Fuel Injection system is equipped with a computer that provides the operator with state-of-the-art control of fuel and spark delivery. Computers use voltage to send and receive information.

Computers and Voltage Signals

Voltage is electrical pressure. Voltage does not flow in circuits. Instead, voltage causes current. Current does the real work in electrical circuits. It is current, the flow of electrically charged particles, that energizes solenoids, closes relays and lights lamps.

Besides causing currents in circuits, voltage can be used as a signal. Voltage signals can send information by changing levels, changing waveform (shape), or changing the speed at which the signal switches from one level to another. Computers use voltage signals to communicate with one another. The different sections inside computers also use voltage signals to communicate with each other.

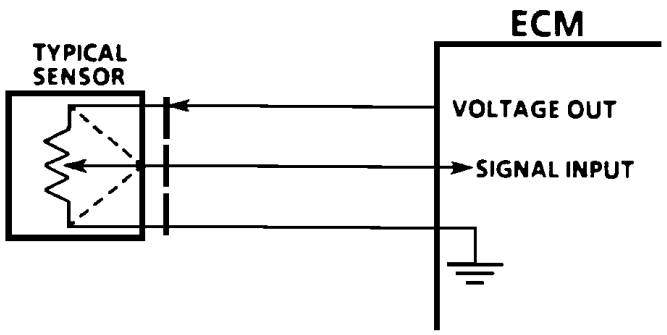
There are two kinds of voltage signals, analog and digital. Both of these are used in computer systems. It's important to understand the difference between them and the different ways they are used.

Analog Signals

An analog signal is continuously variable. This means that the signal can be any voltage within a certain range. An analog signal usually gives information about a condition that changes continuously over a certain range. For example, in a marine engine, temperature is usually provided by an analog signal. There are two general types of sensors that produce analog signals: the 3-wire and the 2-wire sensor.

THREE-WIRE SENSORS (MAP AND TP)

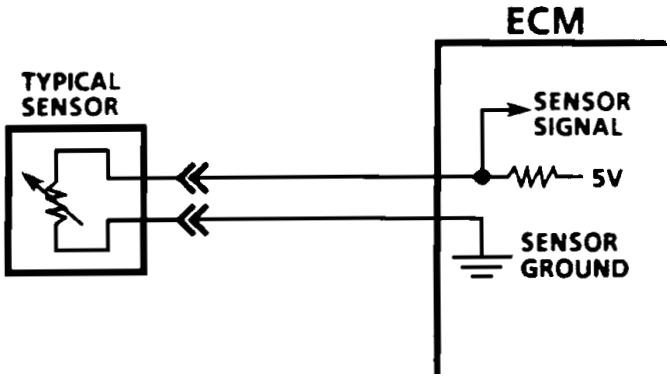
The following figure shows a schematic representation of a 3-wire sensor. All 3-wire sensors have a reference voltage, a ground and a variable "wiper." The lead coming off of the wiper will be the signal to the Engine Control Module (ECM). As this wiper position changes, the signal voltage returned to the computer also changes.



3-Wire Sensor

TWO-WIRE SENSORS (ECT)

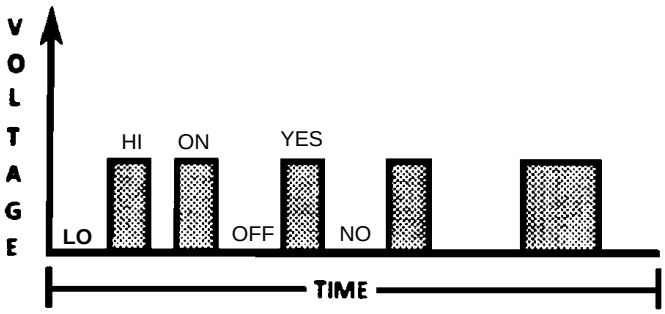
The following figure is the schematic of a 2-wire type sensor. This sensor is basically a variable resistor in series with a fixed-known resistor within the computer. By knowing the values of the input voltage and the voltage drop across the known resistor, the value of the variable resistor can be determined. The variable resistors that are commonly used are called thermistors. A thermistor's resistance varies inversely with temperature.



2-Wire Sensor

Digital Signals

Digital signals are also variable, but not continuously. They can only be represented by distinct voltages within a range. For example, 1 V, 2 V or 3 V would be allowed, but 1.27 V or 2.65 V would not. Digital signals are especially useful when the information can only refer to two conditions - “YES” and “NO,” “ON” and “OFF,” or “High” and “Low.” This would be called a digital binary signal. A digital binary signal is limited to two voltage levels. One level is a positive voltage, the other is no voltage (zero volts). As you can see in the following figure, a digital binary signal is a square wave.



Digital Binary Signal

The computer uses digital signals in a code that contains only ones and zeros. The high voltage of the digital signal represents a one (1), and no voltage represents a zero (0). Each zero and each one is called a bit of information, or just a “bit.” Eight bits together are called a “word.” A word, therefore, contains some combination of eight binary code bits: eight ones, eight zeros, five ones and three zeros, and so on.

Binary code is used inside a computer and between a computer and any electronic device that understands the code. By stringing together thousands of bits, computers can communicate and store an infinite variety of information. To a computer that understands binary, 11001011 might mean that it should reset engine RPM at a lower level. Although the computer uses 8-bit digital codes internally and when talking to another computer, each bit can have a meaning.

SWITCH TYPES

Switched inputs (also known as discretes) to the computer can cause one bit to change, resulting in information being communicated to the computer. Switched inputs can come in two types: they are “pull-up” and “pull-down” types. Both types will be discussed.

With a pull-up type switch, the ECM will sense a voltage when the switch is CLOSED. With the pull-down switch, the ECM recognizes the voltage when the switch is OPEN.

Discretes can also be used to inform a computer of FREQUENCY information.

PULSE COUNTERS

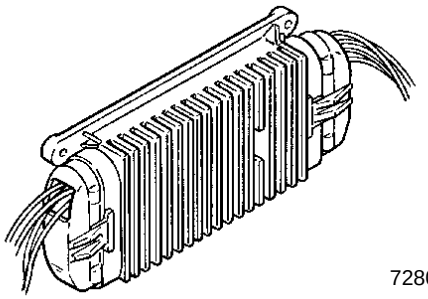
For the computer to determine frequency information from a switched input, the computer must measure the time between voltage pulses. As a number of pulses are recorded in a set amount of time, the computer can calculate the frequency. The meaning of the frequency number can have any number of meanings to the computer.

An example of a pulse counter type of input is the distributor reference pulse input. The computer can count a train of pulses, a given number of pulses per engine revolution, and determine the RPM of the engine.

Engine Control Module (ECM)

The Engine Control Module (ECM) is the control center of the fuel injection system. It constantly monitors information from various sensors, and controls the systems that affect engine performance.

The ECM also performs a diagnostic function check of the system. It can recognize operational problems and store a code or codes which identify the problem areas to aid the technician in making repairs.



Electronic Control Module (ECM)

Index

ECM FUNCTION

The ECM supplies 5 or 12 volts to power various sensors or switches. This is done through resistances in the ECM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, the use of a **10 megohm input impedance digital voltmeter** is required to assure accurate voltage readings.

MEMORY

There are three types of memory storage within the ECM: ROM, RAM and EEPROM.

ROM

Read Only Memory (ROM) is a permanent memory that is physically soldered to the circuit boards within the ECM. The ROM contains the overall control programs. Once the ROM is programmed, it cannot be changed. The ROM memory is non-erasable, and does not need power to be retained.

RAM

Random Access Memory (RAM) is the microprocessor "scratch pad." The processor can write into, or read from, this memory as needed. This memory is erasable and needs a constant supply of voltage to be retained.

EEPROM

Electronic Erasable Programmable Read Only Memory (EEPROM) is the portion of the ECM that contains the different engine calibration information that is specific to each marine application.

Speed Density System

The Electronic Fuel Injection system is a speed and air density system. The system is based on "speed/density" fuel management.

Three specific data sensors provide the ECM with the basic information for the fuel management portion of its operation. That is, three specific signals to the ECM establish the engine speed and air density factors.

SPEED

The engine speed signal comes from the distributor's High Energy Ignition (HEI) module to the ECM on the distributor reference high circuit. The ECM uses this information to determine the "speed" or RPM factor for fuel and ignition management.

DENSITY

The Manifold Absolute Pressure (MAP) sensor is a 3-wire sensor that monitors the changes in intake manifold pressure which results from changes in engine loads. These pressure changes are supplied to the ECM in the form of electrical signals.

As intake manifold pressure increases (vacuum decreases), the air density in the intake manifold also increases, and additional fuel is required.

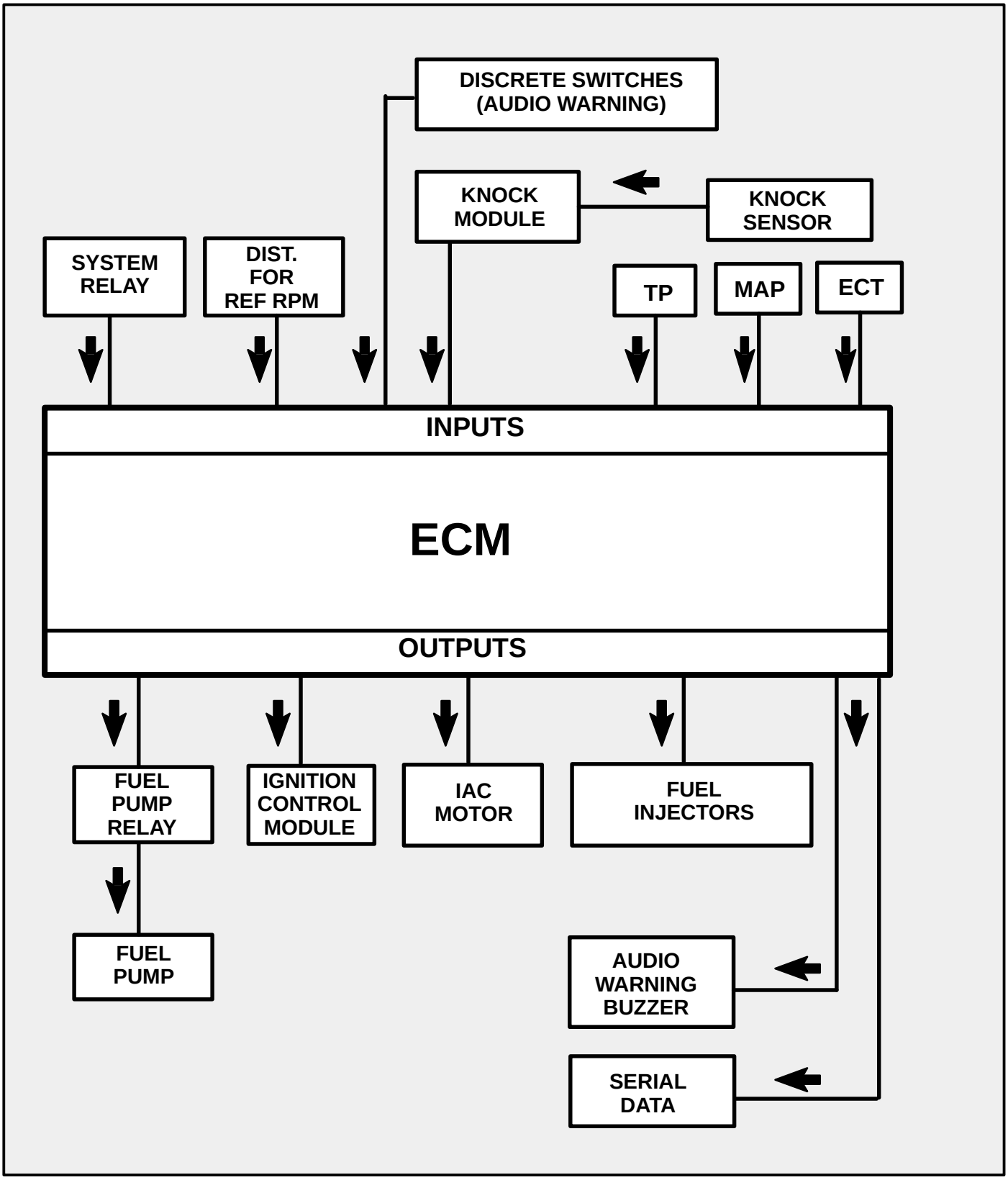
The MAP sensor sends this pressure information to the ECM, and the ECM increases the amount of fuel injected by increasing the injector pulse width. As manifold pressure decreases (vacuum increases), the amount of fuel is decreased.

These two inputs MAP and RPM are the major determinants of the air/fuel mixture, delivered by the fuel injection system.

The remaining sensors and switches provide electrical inputs to the ECM which are used for modification of the air/fuel mixture, as well as for other ECM control functions, such as Idle Air Control (IAC).

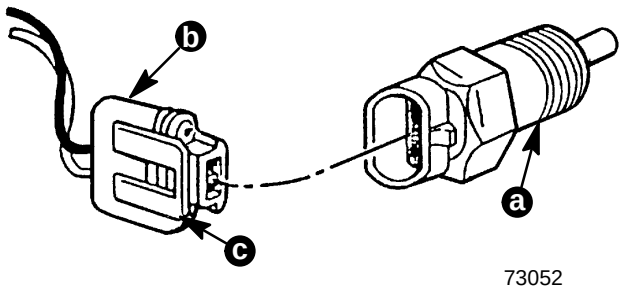
ECM Input and Sensor Descriptions

The following lists the sensors, switches, and other inputs used by the ECM to control its various systems. Although we will not cover them all in great detail, there will be a brief description of each.



ENGINE COOLANT TEMPERATURE (ECT) SENSOR

The Engine Coolant Temperature (ECT) Sensor is a thermistor (a resistor which changes value based on temperature) immersed in the engine coolant stream. Low coolant temperature produces a high resistance, while high temperature causes low resistance.



73052

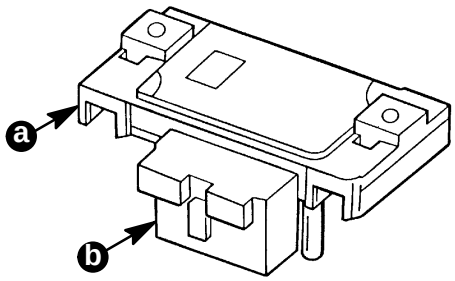
a - Engine Coolant Temperature (ECT) Sensor
b - Harness Connector
c - Locking Tab

The ECM supplies a 5 volt signal to the ECT through a resistor in the ECM and measures the voltage. The voltage will be high when the engine is cold, and low when the engine is hot. By measuring the voltage, the ECM knows the engine coolant temperature. Engine coolant temperature affects most systems the ECM controls.

A failure in the ECT circuit should set Code 14. Remember, this code indicates a failure in the coolant temperature sensor circuit, so proper use of the chart will lead to either repairing a wiring problem or replacing the sensor.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The Manifold Absolute Pressure (MAP) sensor is a pressure transducer that measures the changes in the intake manifold pressure. The pressure changes as a result of engine load and speed change, and the MAP sensor converts this to a voltage output.



73046

a - Manifold Absolute Pressure (MAP) Sensor
b - Electrical Connector

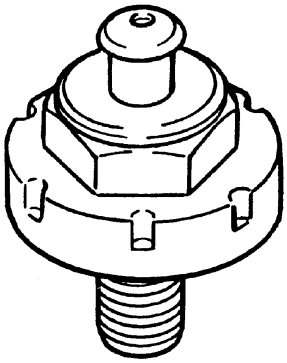
A closed throttle on engine coast-down would produce a relatively low MAP output voltage, while a wide open throttle would produce a high MAP output voltage. This high output voltage is produced because the pressure inside the manifold is the same as outside the manifold, so 100% of outside air pressure is measured. When manifold pressure is high, vacuum is low. The MAP sensor is also used to measure barometric pressure under certain conditions, which allows the ECM to automatically adjust for different altitudes.

The ECM sends a 5 volt reference signal to the MAP sensor. As the manifold pressure changes, the electrical resistance of the MAP sensor also changes. By monitoring the sensor output voltage, the ECM knows the manifold pressure. A higher pressure, low vacuum (high voltage) requires more fuel, while a lower pressure, higher vacuum (low voltage) requires less fuel. The ECM uses the MAP sensor to control fuel delivery and ignition timing.

A failure in the MAP sensor circuit should set a Code 33.

KNOCK SENSOR

The knock sensor is mounted on the lower right side of the engine block.



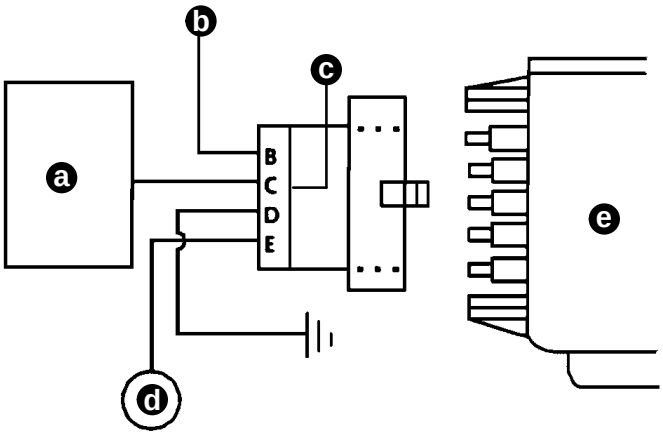
73051

When abnormal engine vibrations (spark knock) are present, the sensor produces a voltage signal which is sent to the KS Module and then to the ECM. The ECM uses this signal to aid in calculating ignition timing.

Index

KNOCK SENSOR (KS) MODULE

The KS module contains solid state circuitry which monitors the knock sensor's AC voltage signal and then supplies an 8-10 volt signal, if no spark knock is present, to the ECM. If spark knock is present, the KS module will remove the 8-10 volt signal to the ECM.



Knock Sensor System

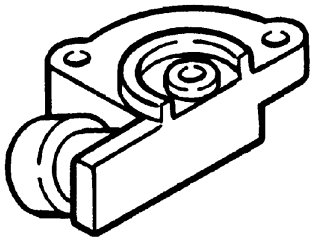
a - Electronic Control Module (ECM)
b - 12 Volts Battery Positive
c - 8-12 Volts
d - Knock Sensor
e - Knock Sensor Module

It is extremely important that the correct KS sensor and module be used for the engine application. Using an incorrect KS module will result in unrecognized spark knock and engine damage. The KS module terminal B is powered by 12 volts from the ignition switch thru system relay. If the 12 volt power source is not present, the KS module cannot send an 8-10 volt signal to the ECM and a false constant spark retard will result. A code 43 will be set.

Terminal E of the KS module is the signal line from the knock sensor. If this circuit opens or shorts to ground, the KS module will never remove the 8-10 volt signal from terminal C to the ECM and no spark retard will occur. The ground circuit for the KS module is connected to terminal D. If the ground circuit opens, the KS module will not be able to remove the 8-10 volt signal to the ECM and spark knock cannot be controlled.

THROTTLE POSITION (TP) SENSOR

The Throttle Position (TP) Sensor is a potentiometer connected to the throttle shaft on the throttle body. The TP has one end connected to 5 volts from the ECM and the other to ECM ground. A third wire is connected to the ECM to measure the voltage from the TP. As the throttle valve angle is changed, the voltage output of the TP also changes. At a closed throttle position, the voltage output of the TP is low (approximately .5 volt). As the throttle valve opens, the output increases so that at wide-open-throttle (W.O.T.), the output voltage should be near 4.5 volts. By monitoring the output voltage from the TP, the ECM can determine fuel delivery based on throttle valve angle (driver demand). A broken or loose TP can cause intermittent bursts of fuel from the injector and an unstable idle, because the ECM thinks the throttle is moving.



73049

If the TP circuit is open, the ECM will set a Code 21. If the TP circuit is shorted, and a trouble Code 21 will be set. A problem in any of the TP circuits will set a Code 21. Once a trouble code is set, the ECM will use a default value for TP.

DISTRIBUTOR REFERENCE (DIST REF)

The distributor reference (engine speed signal) is supplied to the ECM by way of the "Dist Ref Hi" line from the High Energy Ignition (HEI). This pulse counter type input creates the timing signal for the pulsing of the fuel injectors, as well as the Ignition Control (IC) functions. This signal is used for a number of control and testing functions within the ECM.

Spark Management

High Energy Ignition with Ignition Control (IC)

The Electronic Fuel Injection is controlled by an Engine Control Module (ECM). This module is the nerve/decision center of the system. It uses all the information it gathers to manage ignition spark, delivering increased fuel economy and maximum engine performance.

The system uses inputs from sensors to make decisions on the amount of spark advance or retard allowed.

The system has been designed to control ignition advance and retard electronically by the ECM.

In order for the ECM to properly calculate spark advance, it must always know at what speed the engine is running. The engine speed signal is accomplished by a circuit within the distributor module which converts the pickup coil voltage to a square wave reference signal that can be used by the ECM. This square wave engine speed reference signal is known as REF HI. The ECM must also have something to compare the REF HI value against. Therefore, an additional line is provided between the ECM and the distributor module that is known as REF LO. These two lines, between the ECM and the distributor, provide a precise indication of engine speed.

The two other lines between the ECM and distributor which control the Ignition Control (IC) operation are known as the bypass and IC circuits.

Modes Of Operation

There are two modes of ignition system operation:

DISTRIBUTOR MODULE MODE

The ignition system operates independent of the ECM. The distributor module module in the distributor maintains a base ignition timing and is able to advance timing to a total of 27 degrees. This mode is in control when a Code 42 is detected while engine is running and will have a noticeable affect on engine operation.

ECM CONTROL MODE

The ECM control mode controls the ignition timing. The ECM calculates the desired ignition timing based on information it gets from its input sensors.

Distributor Module Mode

The following describes IC operation during cranking and when the engine starts running. To help understand how IC circuits operate, a relay with a double set of contact points is shown in the IC module (refer to the figures “Ignition Control Mode” and “ECM Control Mode”). Solid state circuitry is used in the module, but showing the relay makes it easier to visualize how the IC module functions.

During cranking, the relay is in the de-energized position (see figure “Distributor Module Mode”). This connects the pickup coil to the base of the transistor via the signal converter. When the pickup coil applies a positive voltage to the transistor, the transistor turns ON. When voltage is removed, the transistor turns OFF. When the transistor turns ON, current flows through the primary winding of the ignition coil. When it turns OFF, the primary current stops and a spark is developed at the spark plug. A small amount of advance is built into the IC module via a timing circuit, in case the engine remains in the ignition module timing mode.

With the relay de-energized, a set of contacts (shown closed) would ground the IC line signal.

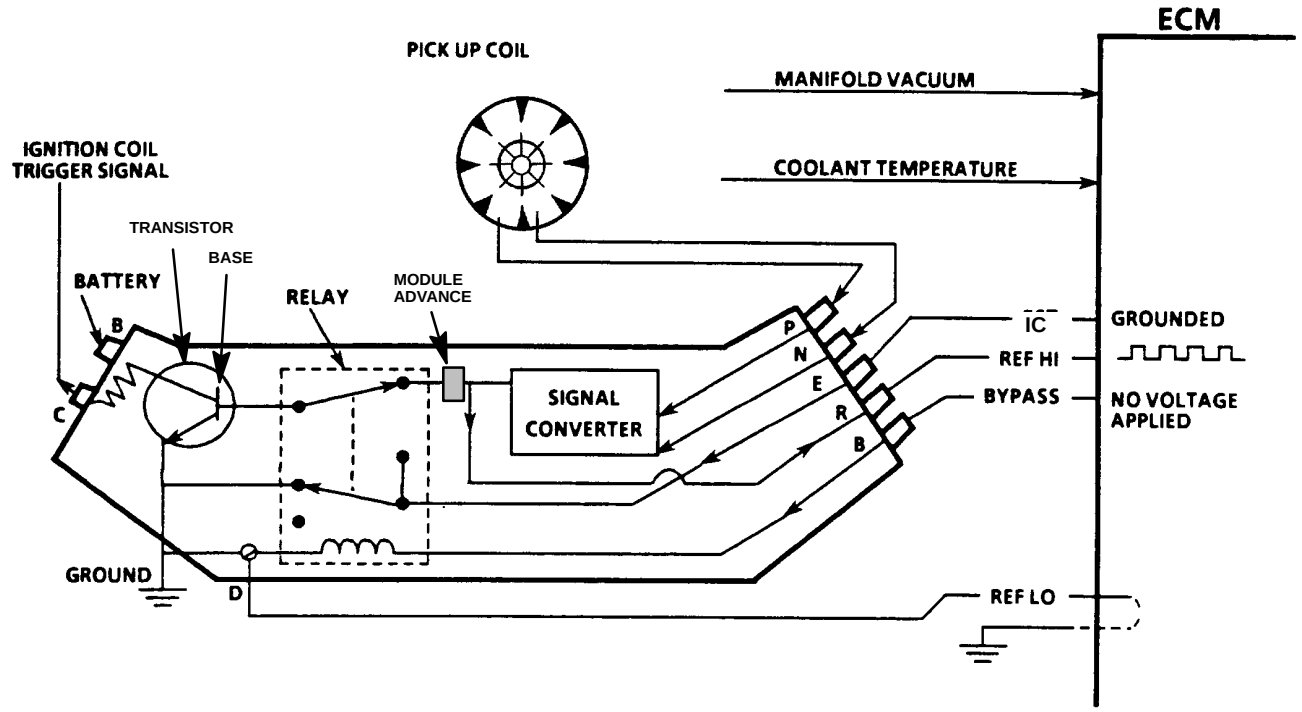
ECM Control Mode

When the engine RPM reaches a predetermined value (for this example, 300 RPM), the ECM considers the engine running and applies five volts on the bypass line to the IC module. This energizes the relay and causes the contacts from the pickup coil as well as the grounding contacts for the IC line to open (see figure “ECM Control Mode”). This connects the IC line to the base of the transistor, and bypasses the ignition module timing control.

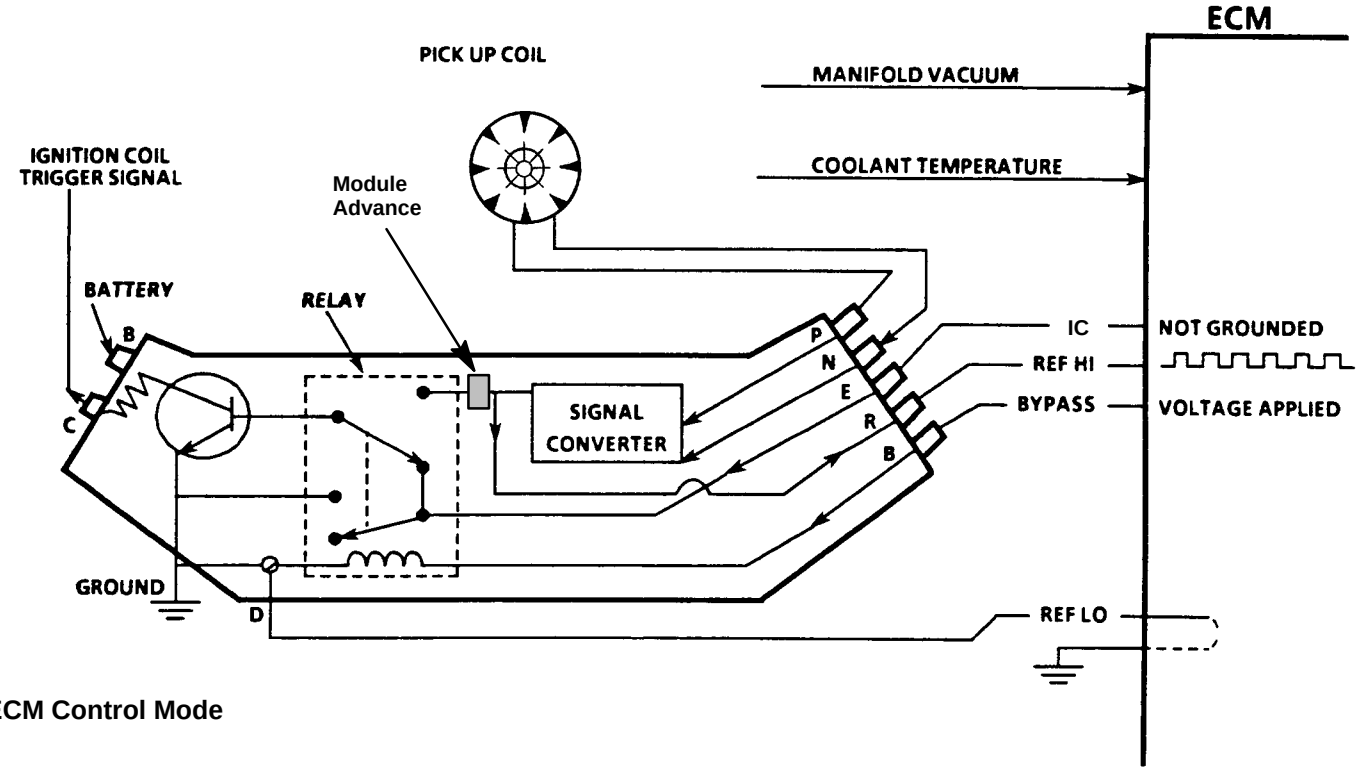
The IC system is now controlled by the IC signal from the ECM and the time at which the spark occurs can be determined by a variable time circuit in the ECM.

Base Ignition Timing

In order to check or change base timing on a HEI system the ECM has to be entered into the service mode by using a scan tool or code tool. The IC module will go to base timing. The ECM will stabilize timing to allow timing adjustment. ’The ECM incorporates a spark control override, which allows timing to be lowered if spark knock (detonation) is encountered during normal operation. At this time, the timing can be adjusted by turning the distributor.



Distributor Module Mode



ECM Control Mode

Results of Incorrect Operation

Open IC Line from the ECM to the Distributor Module - While the engine is cranking, the ECM expects to see the IC signal pulled to virtually zero because it is grounded in the distributor module. Since the IC line is open, it cannot be grounded by the module and the IC signal will be able to rise and fall, or do what is called toggling. The ECM recognizes the toggling as an abnormal condition, and will not apply bypass voltage to the distributor module when the engine reaches run RPM.

Since bypass voltage is not applied to the relay, it remains open and the engine continues to run on the pickup coil triggering in the ignition module timing mode.

If this condition occurs while the engine is running, the engine will stop, but it will restart and run in the ignition module timing mode with reduced power.

Grounded IC Line - During cranking, the IC voltage is at virtually zero so the ECM does not recognize a problem. When engine RPM reaches the value for the run condition, the ECM applies bypass voltage to the distributor module. Bypass voltage on the module switches the distributor power transistor to the IC line. Because the IC line is grounded, it will have no voltage applied so it cannot operate the power transistor to enter the IC mode.

If the IC line becomes grounded while the engine is being operated, the engine will stop and will be difficult to restart.

An open or ground in the IC or bypass will cause the engine to run on the distributor module timing. This will cause reduced performance, poor fuel economy and erratic idle.

Grounded or Open Bypass Line - While the engine is cranking, the IC line will be grounded and the ECM will not notice anything abnormal. When run RPM is reached, the ECM applies bypass voltage to the bypass line but because of the ground or open, it will not be able to energize the relay. Therefore, the relay will stay de-energized and the IC line will remain grounded.

When the ECM sees the IC line not toggling, it will not enter the IC mode. Since the relay is de-energized, the engine will continue to run in the ignition module timing mode.

If this condition occurs while the engine is running, the engine will simply operate in the ignition module timing mode.

Open or Grounded REF HI Line - This line provides the ECM with engine speed information. If this line is open or grounded, the ECM will not know that the engine is cranking or running and will not run.

Open or Grounded REF LO Line - This wire is grounded in the ignition module and provides a reference ground from the ignition module to the ECM. The ECM compares reference ground with reference high voltage. If this circuit is open, or grounded at any other location than through the module, it may cause poor performance.

Fuel Metering System

General Description

The function of the fuel metering system is to deliver the correct amount of fuel to the engine under all operating conditions.
Throttle Body Injection, fuel is delivered from two injectors mounted atop the intake manifold.

Modes of Operation

The ECM looks at voltages from several sensors to determine how much fuel to give the engine. The fuel is delivered under one of several conditions, called modes. All the modes are controlled by the ECM and are described below.

STARTING MODE

When the ignition switch is turned to the crank position, the ECM turns ON the fuel pump relay and the fuel pump builds up pressure. The ECM then checks the Engine Coolant Temperature (ECT) sensor and Throttle Position (TP) sensor and determines the proper air/fuel ratio for starting. The ECM controls the amount of fuel delivered in the starting mode by changing how long the injectors are turned ON and OFF. This is done by pulsing the injectors for very short times.

CLEAR FLOOD MODE

If the engine floods, it can be cleared by opening the throttle half way (50%). (Open throttle handle until resistance from secondary throttle [Multi-Port only] is felt.) The ECM discontinues fuel injector pulsation as long as the throttle is between 50 to 75 % and the engine RPM is below 300. If the throttle position becomes more than 75% or less than 50%, the ECM returns to the starting mode.

RUN MODE

When the engine is started and RPM is above 300, the system operates in the run mode. The ECM will calculate the desired air/fuel ratio based on these ECM inputs: RPM, Manifold Absolute Pressure (MAP) sensor, Intake Air Temperature (IAT) sensor and Engine Coolant Temperature (ECT) sensor . Higher engine load (from MAP) and colder engine temperature (from ECT) requires more fuel, or a richer air/fuel ratio.

ACCELERATION MODE

The ECM looks at rapid changes in Throttle Position (TP) and provides extra fuel by increasing the injector pulse width.

FUEL CUTOFF MODE

No fuel is delivered by the injectors when the ignition is OFF, to prevent dieseling. Also, fuel pulses are not delivered if the ECM receives no distributor reference pulses, which means the engine is not running. The fuel cutoff mode is also enabled at high engine RPM, as an overspeed protection for the engine. When cutoff is in effect due to high RPM, injection pulses will resume after engine RPM drops slightly.

DECELERATION MODE

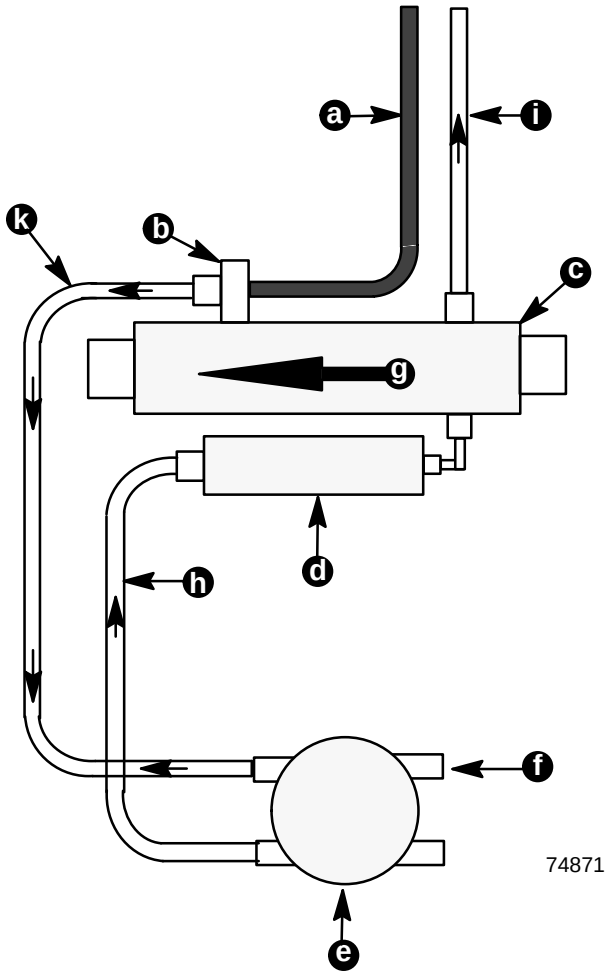
The IAC is similar to a carburetor dashpot. It provides additional air when the throttle is rapidly moved to the idle position to prevent the engine from dying.

Cool Fuel System

The Cool Fuel System consists of an electrical fuel pump, water separating fuel filter and port mounted fuel cooler.

Fuel is drawn from the boat fuel tank through a water separating fuel filter by an electric fuel pump then through fuel cooler. Fuel is fed to fuel injectors in the throttle body. Excess fuel is routed back to water separating fuel filter from the pressure regulator mounted on the fuel cooler.

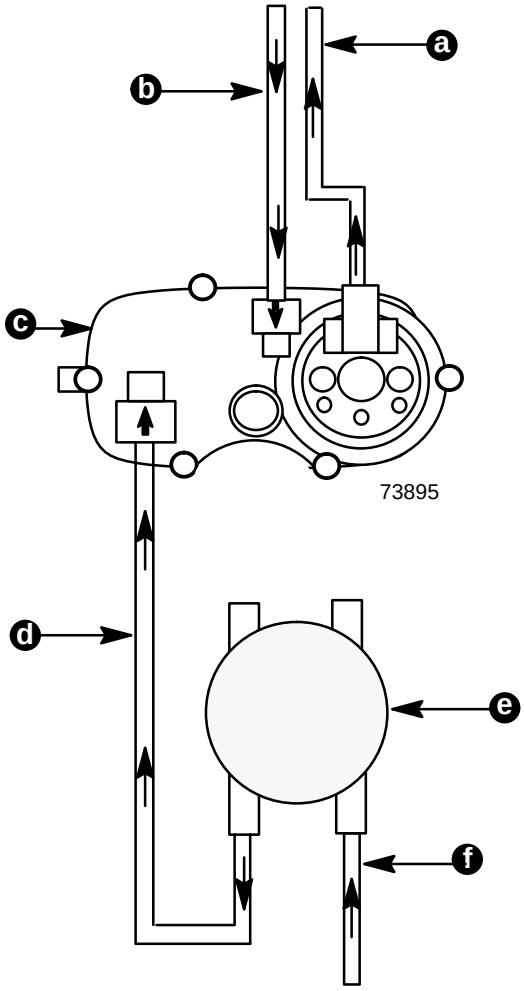
COOL FUEL SYSTEM FUEL FLOW DIAGRAM



Throttle Body Injection System (Typical)

a - Vacuum Line To Flame Arrestor (Throttle Body Injection)
b - Fuel Pressure Regulator
c - Fuel Cooler
d - Electric Fuel Pump
e - Water Separating Fuel Filter
f - Fuel From Tank
g - Direction Of Water Flow
h - Fuel Line To Fuel Pump
i - Fuel Line To Throttle Body
j - Excess Fuel Return To Water Separating Fuel Filter

VAPOR SEPARATOR TANK (VST) FUEL FLOW DIAGRAM



a - Outlet Fuel Line
b - Return Fuel Line
c - Vapor Separator Tank (VST)
d - Fuel Line From Water Separating Fuel Filter
e - Water Separating Fuel Filter
f - Fuel Line From Tank

Throttle Body Injection Components

FUEL PUMP ELECTRICAL COMPONENTS

When the ignition switch is turned to the RUN position, the ECM will turn ON the fuel pump relay for two seconds.

When the ignition switch is turned to the crank position, the ECM turns the fuel pump relay ON causing the fuel pump to start.

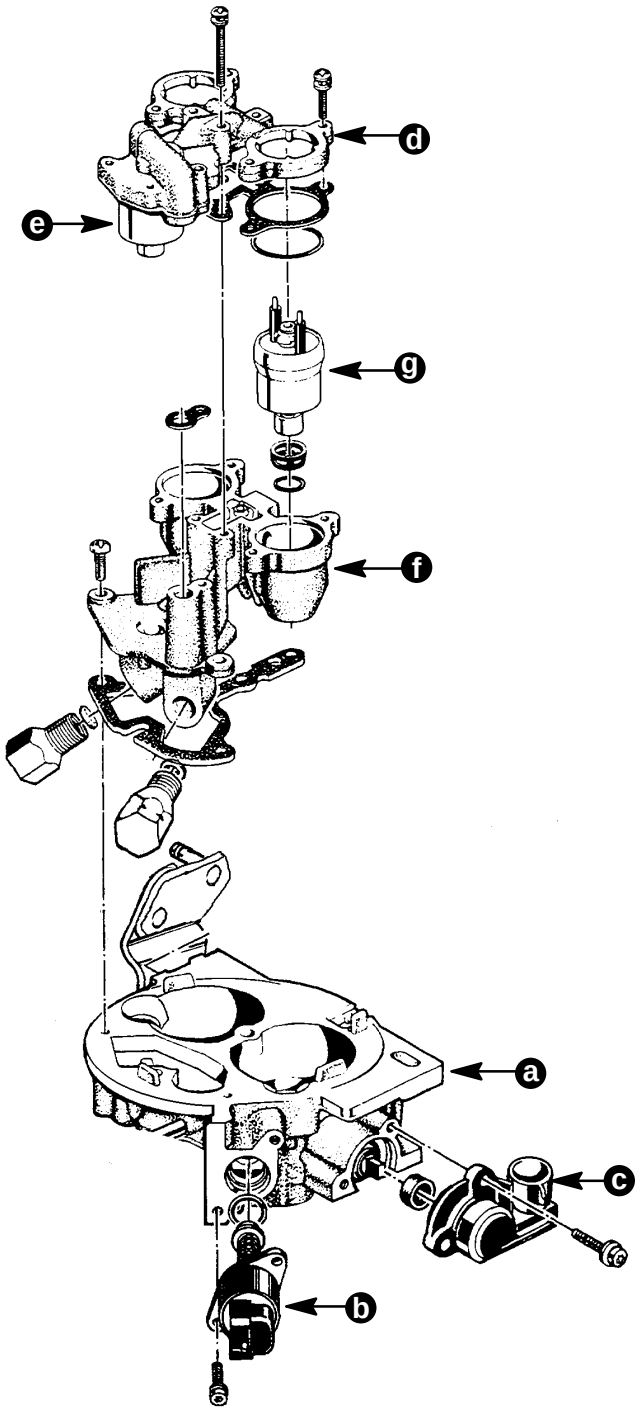
If the ECM does not receive ignition reference pulses (engine cranking or running), it shuts Off the fuel pump relay, causing the fuel pump to stop.

THROTTLE BODY UNIT

The throttle body unit consists of three assemblies.

- Fuel meter cover and fuel damper
- Fuel meter body and fuel injectors
- Throttle Body
  - -Two Throttle Valves To Control Air Flow Into The Engine
  - -Idle Air Control (IAC) Valve
  - -Throttle Position (Tp) Sensor

THROTTLE BODY UNIT EXPLODED VIEW



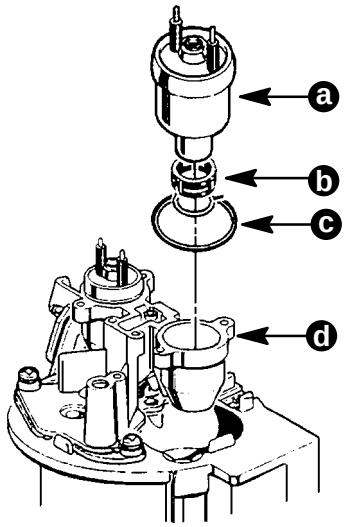
73766

a - Throttle Body
b - Idle Air Control (IAC) Valve
c - Throttle Position (TP) Sensor
d - Fuel Meter Cover
e - Fuel Damper
f - Fuel Meter Body
g - Fuel Injector (2)

FUEL INJECTORS

The injector assembly is a solenoid operated device, controlled by the ECM, that meters pressurized fuel to the intake manifold. The ECM energizes the injector solenoid, which opens a ball valve, allowing fuel to flow past the ball valve, and through a recessed flow director plate.

The director plate has six machined holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel is directed at the throttle, causing it to become further atomized before entering the intake manifold.

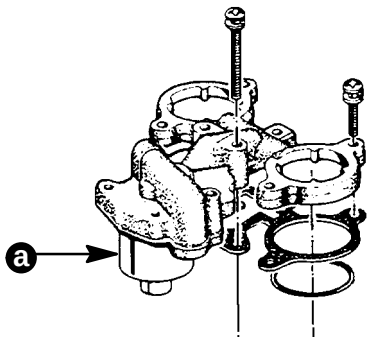


73773

a - Fuel Injector
b - Fuel Filter
c - Seal Ring
d - Fuel Meter Body

FUEL DAMPER

The fuel damper acts as an equalization device to reduce the pressure spikes caused by the fuel injectors.



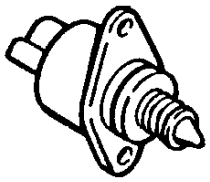
73766

Throttle Body Injection Shown

a - Fuel Damper

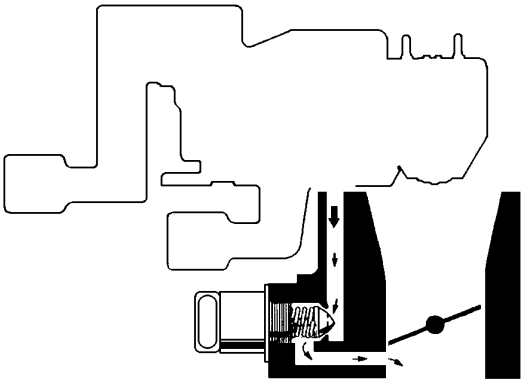
IDLE AIR CONTROL (IAC) VALVE

The purpose of the IAC valve assembly is to control engine idle speed, while preventing stalls due to changes in engine load. The IAC valve, mounted in the throttle body, controls bypass air around the throttle valves.



72800

Idle Air Control (IAC) Valve Assembly



IAC Valve Air Flow Diagram

By moving a conical valve known as a pintle, IN, toward the seat (to decrease air flow), or OUT, away from the seat (to increase air flow), a controlled amount of air moves around the throttle valve. If RPM is too low, more air is bypassed around the throttle valve to increase it. If RPM is too high, less air is bypassed around the throttle valve to decrease it.

The ECM moves the IAC valve in small steps, called counts. These can be measured by scan tool test equipment, which plugs into the DLC connector.

During idle, the proper position of the IAC valve is engine load, and engine RPM. If the RPM drops below specification and the throttle valve is closed, the ECM senses a near stall condition and calculates a new valve position to prevent stalling.

- Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position.
- "Controlled" idle speed is programmed into the ECM, which determines the correct IAC valve pintle position to maintain the desired idle speed for all engine operating conditions and loads.
- The minimum idle air rate is set at the factory with stop screws. This setting allows enough air flow by the throttle valves to cause the IAC valve pintle to be positioned a calibrated number of steps (counts) from the seat during "controlled" idle operation.
- If the IAC valve is disconnected and reconnected with the engine running, the idle speed may be wrong. In this case, the IAC valve can be reset by doing the following: Turn off engine, wait ten seconds, and restart engine.

The purpose of the IAC valve assembly is to control engine idle speed, while preventing stalls due to changes in engine load. The IAC valve, mounted in the throttle body, controls bypass air around the throttle valves.

By moving a conical valve known as a pintle, IN, toward the seat (to decrease air flow), or OUT, away from the seat (to increase air flow), a controlled amount of air moves around the throttle valve. If RPM is too low, more air is bypassed around the throttle valve to increase it. If RPM is too high, less air is bypassed around the throttle valve to decrease it.

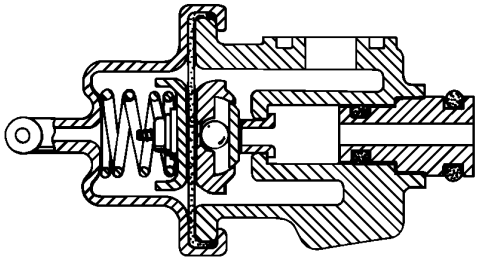
The ECM moves the IAC valve in small steps, called counts. These can be measured by scan tool test equipment, which plugs into the DLC.

During idle, the proper position of the IAC valve is based on engine RPM. If the RPM drops below specification and the throttle valve is closed, the ECM senses a near stall condition and calculates a new valve position to prevent stalling.

- Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position + throttle valve stop screws and PCV.
- "Controlled" idle speed is programmed into the ECM, which determines the correct IAC valve pintle position to maintain the desired idle speed for all engine operating conditions and loads.
- The minimum idle air rate is set at the factory with stop screws. This setting allows enough air flow by the throttle valves to cause the IAC valve pintle to be positioned a calibrated number of steps (counts) from the seat during "controlled" idle operation.
- If the IAC valve is disconnected and reconnected with the engine running, the idle speed may be wrong. In this case, the IAC valve can be reset by doing the following: turn off engine, wait ten seconds, and restart engine.

PRESSURE REGULATOR ASSEMBLY

The pressure regulator is a diaphragm-operated relief valve with fuel pump pressure on one side, and regulator spring pressure and intake manifold vacuum on the other. The regulator's function is to maintain a constant pressure differential across the injectors at all times. The pressure regulator compensates for engine load by increasing fuel pressure as engine vacuum drops.



71716

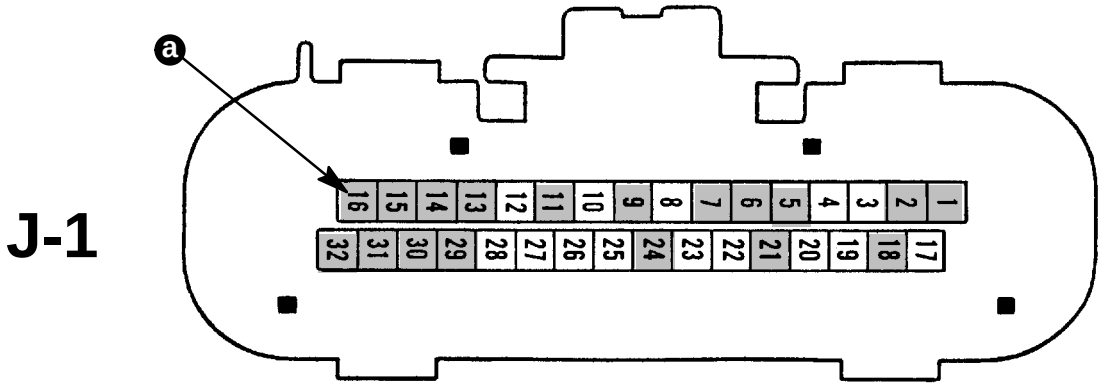
THIS PAGE IS INTENTIONALLY BLANK

ECM Connector and Symptom Charts

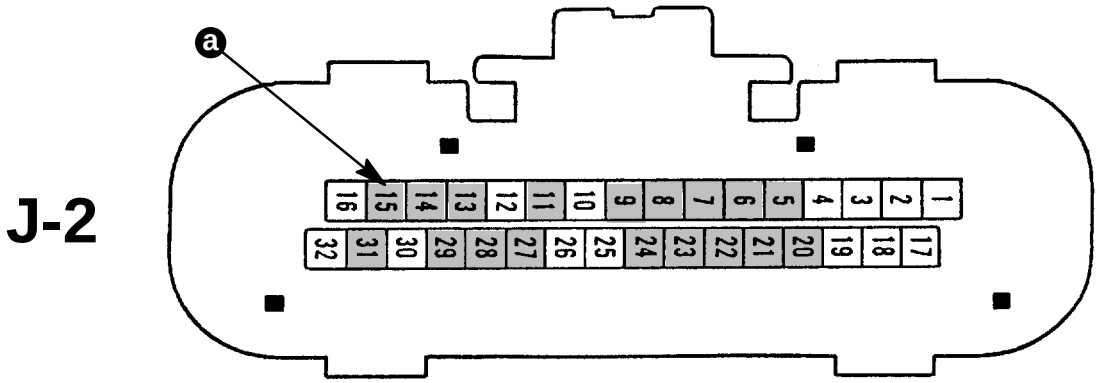
The following chart will aid in diagnosis of symptoms. These voltages were derived from a known good engine. The voltages shown were done with the electrical system intact and operational. These are voltage requirements to operate the different circuits.

⚠CAUTION

Do not attempt to obtain these voltages by probing wires and connectors. Serious damage could result in loss of engine operation or wiring damage. Voltages can vary with battery conditions.



J-1 Front Pin 32 Pin Input Connector



J-2 Rear 32 Pin Output Connector
a - Shaded Area Denotes Pin Connector Location Used On Terminal

IMPORTANT: The following conditions must be meet before testing.

1. Engine at operating temperature.
2. Ignition on or engine running.
3. Scan tool not connected.

THESE NOTES APPLY TO FOLLOWING ECM CONNECTOR AND SYMPTOM CHARTS.
The "B+" Symbol indicates a system voltage (battery).

NOTE 1: Battery voltage for first two seconds, then 0 volts.

NOTE 2: Varies with temperature.

NOTE 3: Varies with manifold vacuum.

NOTE 4: Varies with throttle movement.

NOTE 5: Less than .5 volt (500 mV).

NOTE 6: Dual or multiple engines must share a common ground (–) for proper serial data communications.

Index

ECM Connector and EFI Symptoms Chart (J-1 Circuits)

Pin	Pin Function	Circuit (CKT) Number (#)	Wire Color	Normal Voltage		Diagnostic Trouble Codes DTC(s)	Possible Symptoms
				Ignition ON	Engine Running		
J1-1	Knock Sensor Signal	485	BLK	9.5V	9.5V	43	Poor Fuel Economy, Poor Performance Detonation
J1-2	ECT Signal	410	YEL	1.95V (NOTE 2)	1.95V (NOTE 2)	14	Poor Performance, Exhaust Odor, Rough Idle RPM Reduction
J1-3	Not Used	–	–	–	–	–	–
J1-4	Not Used	–	–	–	–	–	–
J1-5	Master/ Slave	916	YEL	B+	B+	None	Lack Of Data From Other Engine (Dual Engine Only)
J1-6	Discrete Switch	931	BRN	–	–	None	Power Reduction Mode
J1-7	Diagnostic Test	451	WHT/ BLK	B+	B+	None	Incorrect Idle, Poor Performance
J1-8	Not Used	–	–	–	–	–	–
J1-9	Map Signal	432	LT GRN	4.9V	1.46V (NOTE 3)	33	Poor Performance, Surge, Poor Fuel Economy, Exhaust Odor
J1-10	TP Signal	417	DK BLU	.62V (NOTE 4)	.62V (NOTE 4)	21	Poor Performance And Acceleration, Incorrect Idle
J1-11	Ignition Fused	439	PNK/ BLK	B+	B+	None	No Start
J1-12	Not Used	–	–	–	–	–	–
J1-13	TP Ground	813	BLK	0 (NOTE 5)	0 (NOTE 5)	21,23	High Idle, Rough Idle, Poor Performance Exhaust Odor
J1-14	ECM Ground	450	BLK/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	No Start
J1-15	TP 5V Reference	416	GRY	5V	5V	21	Lack Of Power, Idle High
J1-16	Battery	440	ORN	B+	B+	None	No Start

See Page 5D-25 For NOTES

ECM Connector and EFI Symptoms Chart (J-1 Circuits)

Pin	Pin Function	Circuit (CKT) Number (#)	Wire Color	Normal Voltage		Diagnostic Trouble Codes DTC(s)	Possible Symptoms
				Ignition ON	Engine Running		
J1-17	Not Used	–	–	–	–	–	–
J1-18	Serial Data	461	ORN/ BLK	5V	5V	None	No Serial Data (NOTE 6)
J1-19	Not Used	–	–	–	–	–	–
J1-20	Not Used	–	–	–	–	–	–
J1-21	Lanyard Stop Switch	942	PNK	0	0	NONE	No Start
J1-22	Not Used	–	–	–	–	–	–
J1-23	Not Used	–	–	–	–	–	–
J1-24	Not Used	–	–	–	–	–	–
J1-25	Not Used	–	–	–	–	–	–
J1-26	Not Used	–	–	–	–	–	–
J1-27	Not Used	–	–	–	–	–	–
J1-28	Not Used	–	–	–	–	–	–
J1-29	MAP Ground	814	BLK	0 (NOTE 5)	0 (NOTE 5)	33	Lack Of Performance,Exhaust Odor, Stall
J1-30	ECM Ground	450	BLK/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	No Start
J1-31	MAP 5V Reference	416	GRY	5V	5V	33	Lack Of Power, Surge, Rough Idle, Exhaust Odor
J1-32	Battery	440	ORN	B+	B+	None	No Start

See page 5D-25 for NOTES

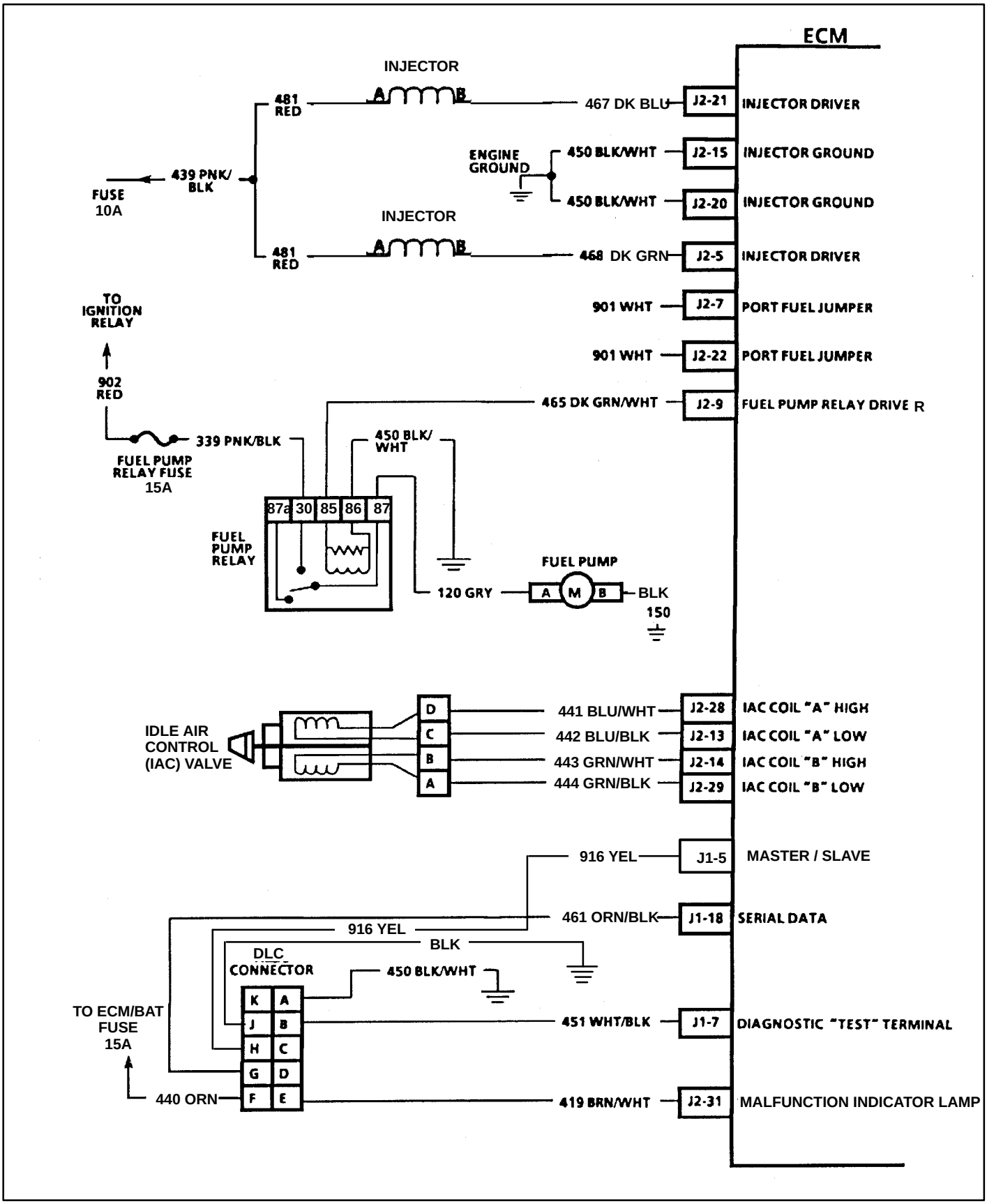
ECM Connector and EFI Symptoms Chart (J-2 Circuits)

Pin	Pin Function	Circuit (CKT) Number (#)	Wire Color	Normal Voltage		Diagnostic Trouble Codes DTC(s)	Possible Symptoms
				Ignition ON	Engine Running		
J2-1	Not Used	–	–	–	–	–	–
J2-2	Not Used	–	–	–	–	–	–
J2-3	Not Used	–	–	–	–	–	–
J2-4	Not Used	–	–	–	–	–	–
J2-5	Injector Driver	468	LT GRN	B+	B+	None	Rough Idle, Lack Of Power, Stall
J2-6	Ignition Control Ref. Low	463	BLK/ RED	0 (NOTE 5)	0 (NOTE 5)	None	Poor Performance
J2-7	Not Used	–	–	–	–	–	–
J2-8	Ignition Control Ref. High	430	PUR/ WHT	5V	1.6V	None	No Restart
J2-9	Fuel Pump Relay Driver	465	DK GRN/ WHT	0 (NOTE 1&5)	B+	None	No Start
J2-10	Not Used	–	–	–	–	–	–
J2-11	Coolant Over temp.	112	DK GRN	0	0	NONE	Power Reduction Mode or Improper Audio Warning
J2-12	Not Used	–	–	–	–	–	–
J2-13	IAC "A" Low	442	BLU/ BLK	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J2-14	IAC "B" Low	443	GRN/ WHT	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J2-15	Injector Ground	450	BLK/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	Rough Running, Lack Of Power, Poor Performance
J2-16	Not Used	–	–	–	–	–	–

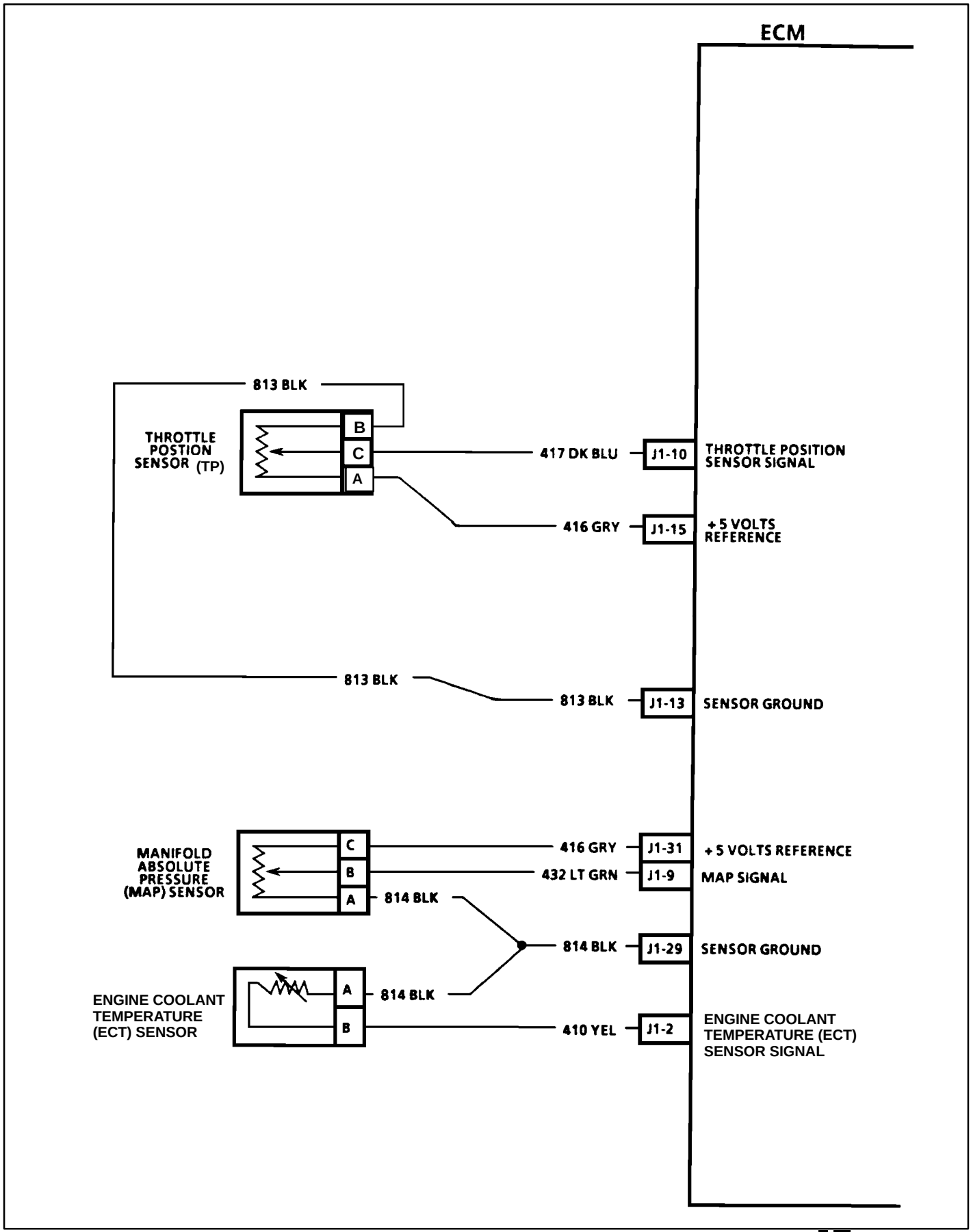
ECM Connector and EFI Symptoms Chart (J-2 Circuits)

Pin	Pin Function	Circuit (CKT) Number (#)	Wire Color	Normal Voltage		Diagnostic Trouble Codes DTC(s)	Possible Symptoms
				Ignition ON	Engine Running		
J2-17	Not Used	–	–	–	–	–	–
J2-18	Not Used	–	–	–	–	–	–
J2-19	Not Used	–	–	–	–	–	–
J2-20	Fuel Injector Ground	450	BLK/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	Rough Running, Poor Idle, Lack Of Performance
J2-21	Injector Driver	467	DK BLU	B+	B+	None	Rough Idle, Lack Of Power, Stalling
J2-22	Not Used	–	–	–	–	–	–
J2-23	Ignition Control Signal	423	WHT	0 (NOTE 5)	1.2V	42	Stall, Will Restart In Bypass Mode, Lack Of Power
J2-24	Ignition Control Bypass	424	TAN/ BLK	0 (NOTE 5)	4.5V	42	Lack Of Power, Fixed Timing
J2-25	Not Used	–	–	–	–	–	–
J2-26	Not Used	–	–	–	–	–	–
J2-27	Discrete Switch Signal	31	TAN	–	–	–	Audio Warning System Activated
J2-28	IAC ”A” High	441	BLU/ WHT	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J2-29	IAC ”B” Low	444	GRN/ BLK	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J2-30	Not Used	–	–	–	–	–	–
J2-31	MIL Lamp	419	BRN/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	Lamp Inoperative
J2-32	Not Used	–	–	–	–	–	–

Throttle Body Injection Wiring Diagram (Chart 1 of 4)

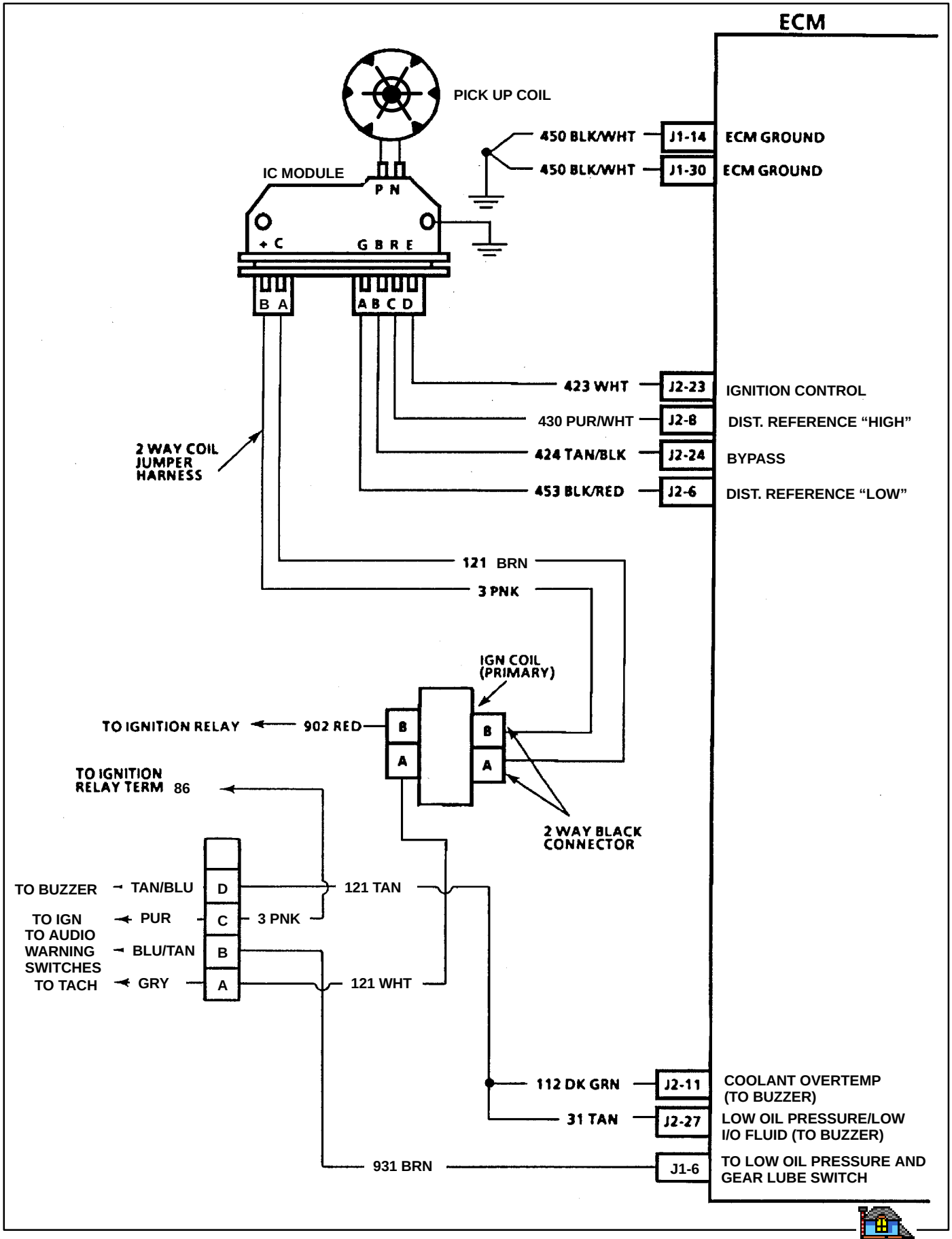


Throttle Body Injection Wiring Diagram (Chart 2 Of 4)



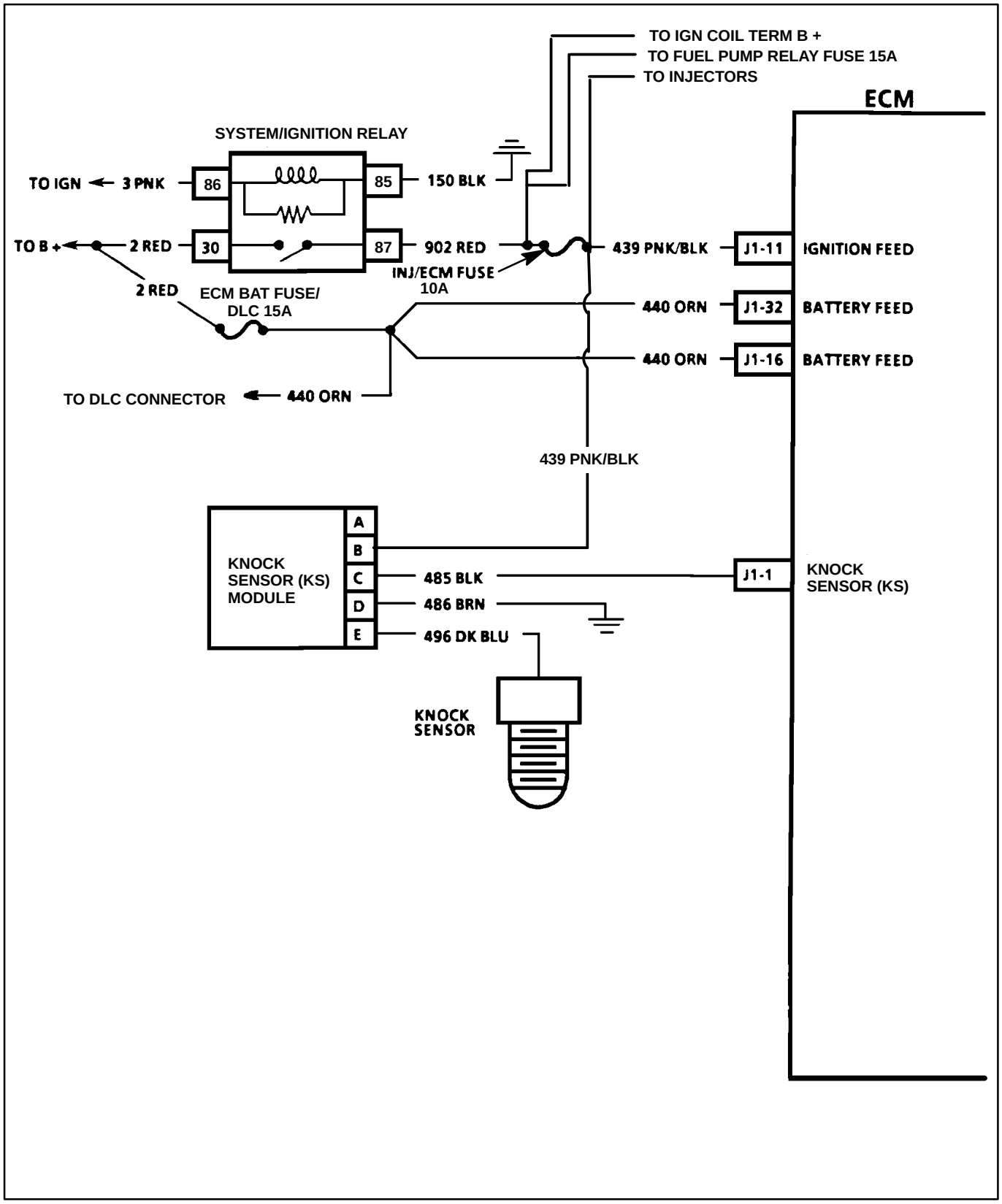
Index

Throttle Body Injection Wiring Diagram (Chart 3 Of 4)



Index

Throttle Body Injection Wiring Diagram (Chart 4 Of 4)



THIS PAGE IS INTENTIONALLY BLANK

Diagnostic Circuit Check

The Diagnostic Circuit Check is an organized approach to identifying a problem created by an electronic engine control system malfunction. It must be the starting point for any driveability complaint diagnosis because it directs the service technician to the next logical step in diagnosing the complaint.

NOTE: *A scan tool that displays faulty data should not be used, and the problem should be reported to the manufacturer. The use of a faulty scan tool can result in misdiagnosis and unnecessary parts replacement.*

The scan tool data listed in the table may be used for comparison. After completing the diagnostic circuit check and finding the on-board diagnostics functioning properly and no trouble codes displayed. The "Typical Data Values" are an average of display values recorded from normally operating vessels and are intended to represent what a normally functioning system would typically display.

Only the parameters listed below are used in this manual for diagnosing. If a scan reads other parameters, the values are not recommended for use in diagnosing. If all values are within the range illustrated, refer to "Troubleshooting."

Scan Tool Normal Specifications (Idle /Warm Engine/Closed Throttle/Neutral)

Scan Position	Units Displayed	Typical Data Value
RPM	RPM	600-700 RPM
Desired RPM	RPM	600 RPM
Coolant Temperature	° F(° C)	150-170° F (66-77° C)
Manifold Air Temperature	° F (° C)	Varies with Ambient Temperature
Throttle Position	Volts	.4 to .8 Volts
Throttle Angle	0-100 %	0-1%
MAP	Volts or kPa	1-3 Volts or (45-55 kPa) (Depends on Vacuum and Baro Pressure)
Baro	Volts or kPa	3-5 Volts (Depends on Altitude and Barometric Pressure)
Bat	Volts	12.0-14.5 Volts
Spark Advance	Degrees	-10 to 30°
Knock Retard	Degrees	0°
Idle Air Control IAC	Counts (Steps)	0-40 Counts
Minimum IAC Position	Counts (Steps)	0-40 Counts
Idle Air Control Follower	Counts (Steps)	0 Counts
Injector Pulse Width	msec.	2-3 msec.
Injector On Time Cranking	msec.	2.5–3.5 msec. (Depends on Water/Air Temperature)
Fuel Consumption	GPH (L/h)	1-2 GPH (3.7-7.5 L/h)
Time From Start	0:00:00-1092:00	Varies
Memory Calibration Check Sum	Calibration and Check Sum	Varies with Software revision in ECM
Oil Press/IO Level (See Note)	OK/LO	OK
Engine Overtemp	OK/Overheating	OK
Lanyard Stop Mode	OFF/ON	OFF

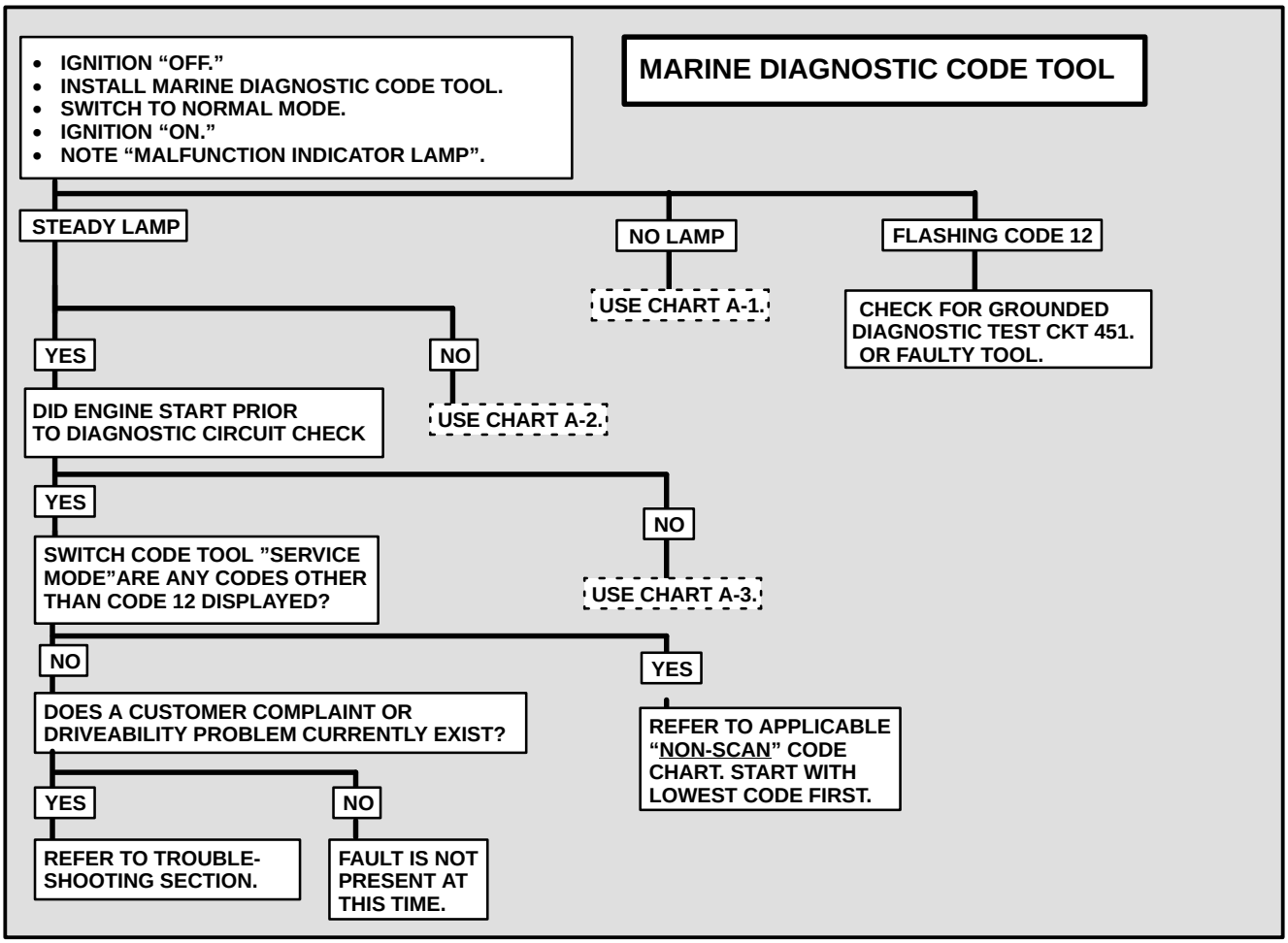
NOTE: MCM will read I/O Level

CLEARING CODES USING <u>DIAGNOSTIC CODE TOOL</u> (NON-SCAN)

1. Install diagnostic code tool.
2. Turn key ON.
3. Select service mode on code tool.
4. To clear codes, move the throttle, while in neutral, from 0% to 100% then back to 0%.
5. Exit “Service Mode” on code tool.
6. Start engine and let run for fifteen seconds.
7. Turn key OFF for 5 seconds.
8. Select “Service Mode” on code tool.
9. Turn key ON and read codes. If codes are still present, check note following and repeat from Step 1.
10. Refer to appropriate Troubleshooting and/or Diagnostic Charts

NOTE: *When clearing codes without the use of a scan tool, the battery must be fully charged and cranking speed must be at least 300 RPM. The ability to clear codes is directly dependent on the battery being fully charged and able to start the engine with adequate cranking RPM.*

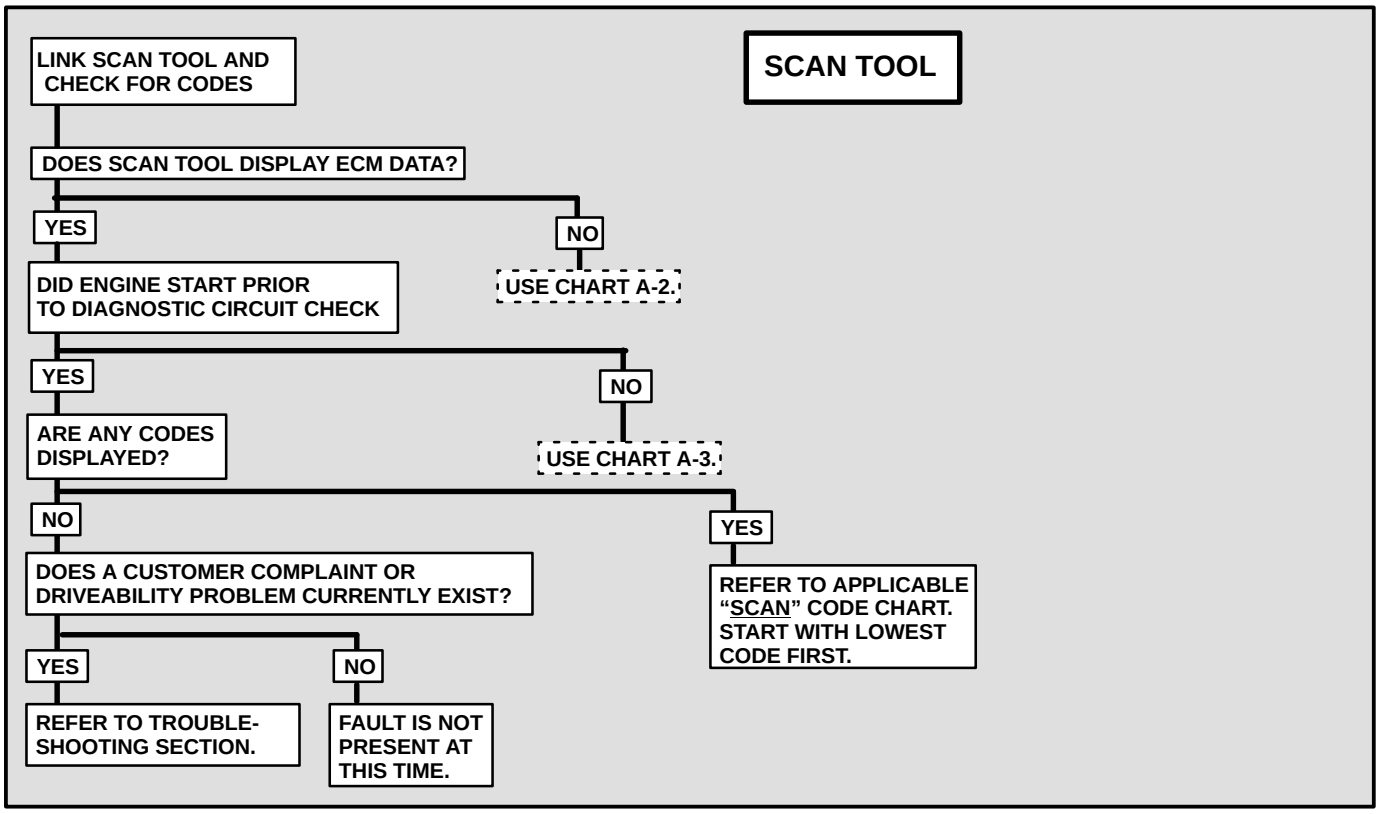
A poorly charged battery or engine cranking problem may result in an ECM “reset” and may not allow stored trouble codes to be cleared from EEPROM memory. If this condition exists, BE SURE the battery is fully charged. If a low battery condition does exists the audio warning buzzer will come on for 2 seconds after engine start-up.



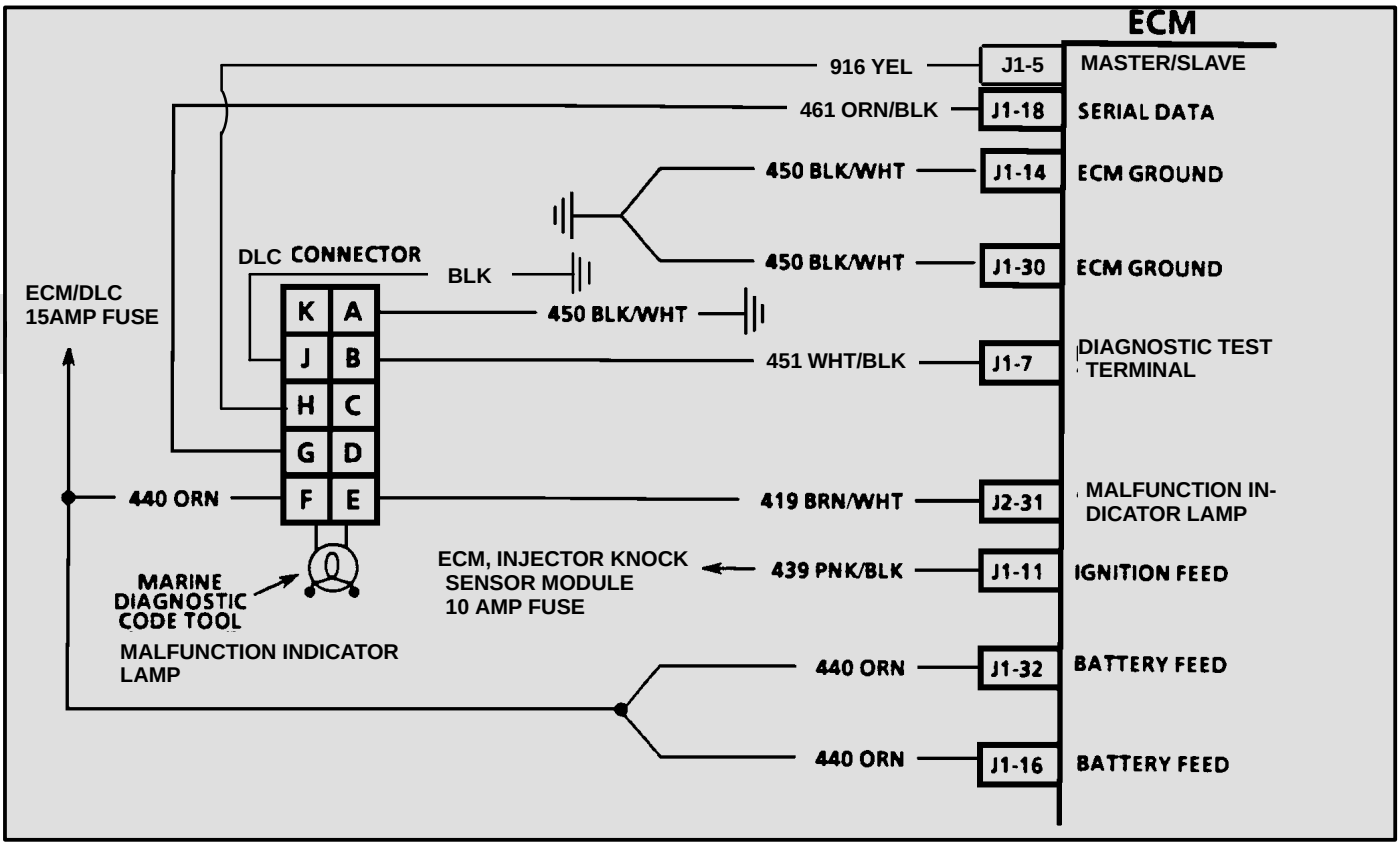
Index

CLEARING CODES USING SCAN TOOL (SCAN)

1. Connect scan tool.
2. Start engine.
3. Select clear codes function.
4. Clear codes.
5. Turn key OFF.
6. Turn key ON and read codes. If codes are still present, (there is a real fault in system) check note preceding and repeat Step 1.



No “Malfunction Indicator Lamp” (Marine Diagnostic Code Tool Installed)
Chart A-1 (1 of 2)



CIRCUIT DESCRIPTION:

There should always be a steady “Malfunction Indicator Lamp” when the ignition is ON and engine stopped. Ignition voltage is supplied directly to the light bulb. The Electronic Control Module (ECM) will control the light and turn it ON by providing a ground path through CKT 419 to the ECM.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step insures that battery voltage is available to terminal “F” of the DLC connector.
2. This step checks for ground present in DLC connector terminal “E.” This indicates that the ECM is capable of completing the ground to the “Malfunction Indicator Lamp”.
3. This step isolates the cause of incomplete ground to either a wiring or ECM circuitry.
4. If the engine fails to crash, this may indicate a failure in the starting system circuit.

DIAGNOSTIC AIDS:

Engine runs OK, check:

- Faulty light bulb.
- CKT 419 open.

Engine cranks but will not run, check:

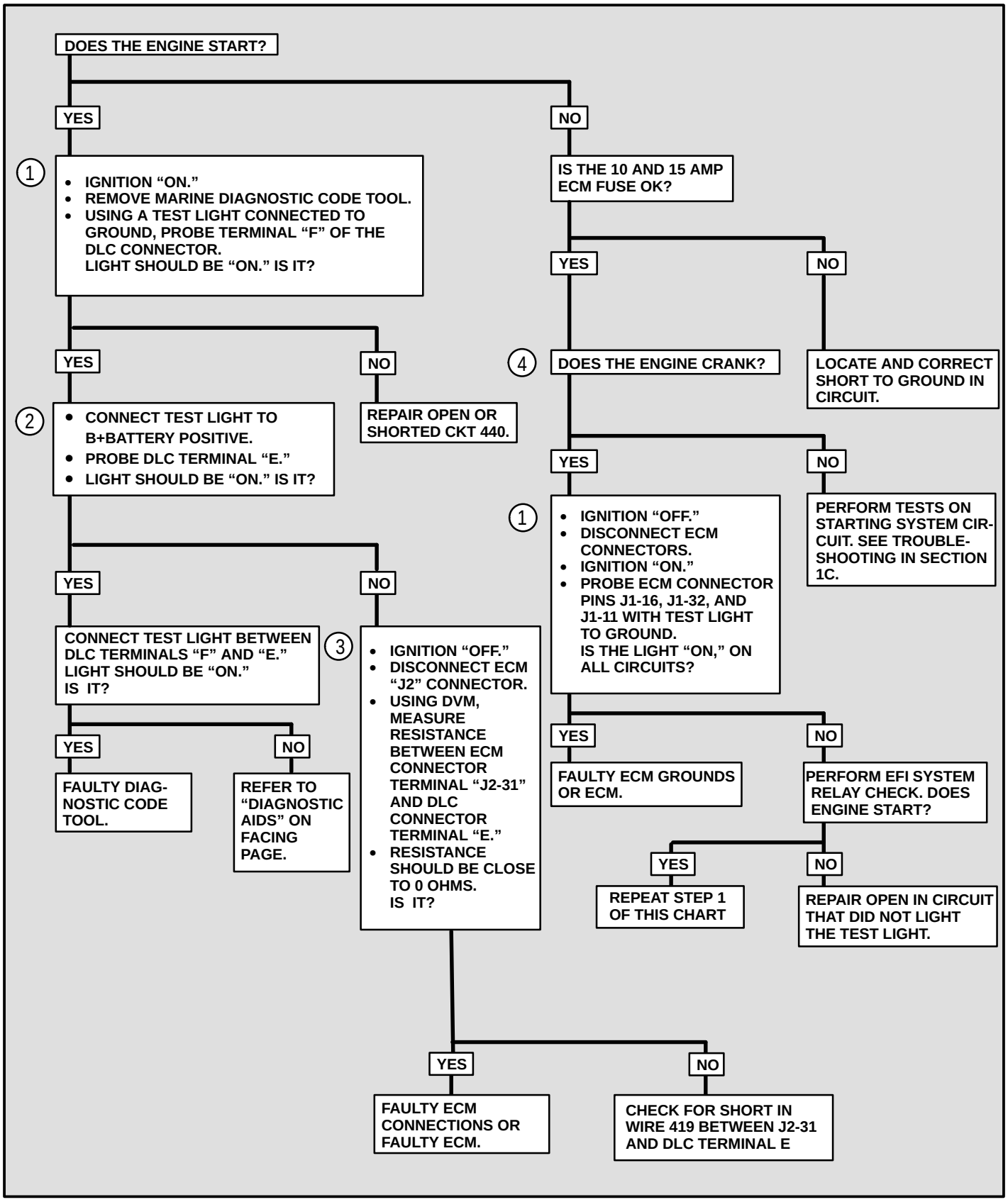
- Continuous battery - 50 amp circuit breaker open.
- Open ECM fuse.
- Battery circuit to ECM open.
- Ignition circuit to ECM open.
- Poor connection to ECM.
- Faulty ECM ground circuit(s).

Engine will not crank.

- Perform EFI system relay check.

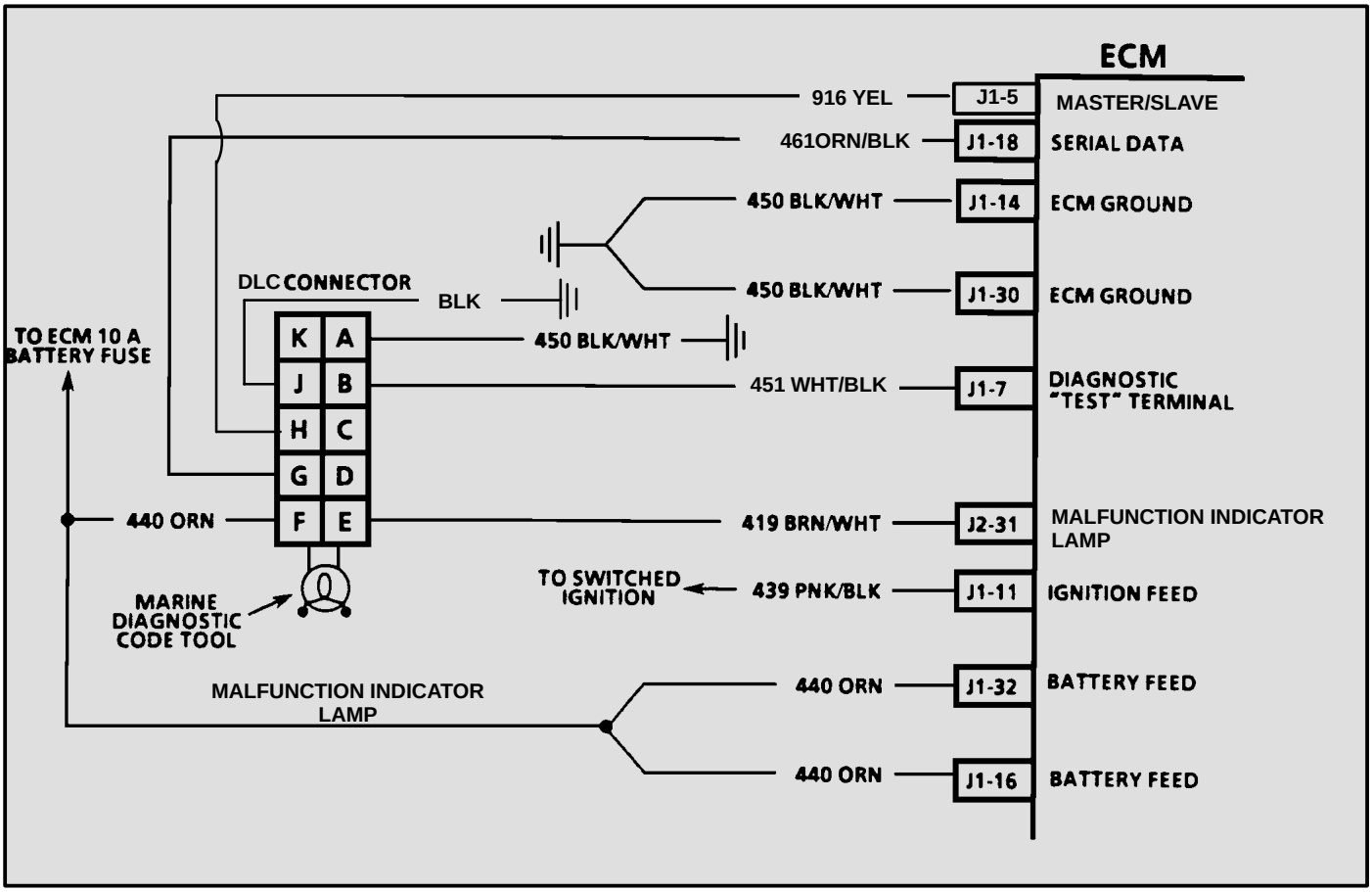
Index

No “Malfunction Indicator Lamp”
Chart A-1: (2 of 2)


DOES THE ENGINE START?
YES
NO
1
IGNITION “ON.”
REMOVE MARINE DIAGNOSTIC CODE TOOL.
USING A TEST LIGHT CONNECTED TO GROUND, PROBE TERMINAL “F” OF THE DLC CONNECTOR.
LIGHT SHOULD BE “ON.” IS IT?
YES
NO
REPAIR OPEN OR SHORTED CKT 440.
2
CONNECT TEST LIGHT TO B+BATTERY POSITIVE.
PROBE DLC TERMINAL “E.”
LIGHT SHOULD BE “ON.” IS IT?
YES
NO
CONNECT TEST LIGHT BETWEEN DLC TERMINALS “F” AND “E.” LIGHT SHOULD BE “ON.” IS IT?
YES
NO
FAULTY DIAGNOSTIC CODE TOOL.
REFER TO “DIAGNOSTIC AIDS” ON FACING PAGE.
3
IGNITION “OFF.”
DISCONNECT ECM “J2” CONNECTOR.
USING DVM, MEASURE RESISTANCE BETWEEN ECM CONNECTOR TERMINAL “J2-31” AND DLC CONNECTOR TERMINAL “E.”
RESISTANCE SHOULD BE CLOSE TO 0 OHMS. IS IT?
YES
NO
FAULTY ECM CONNECTIONS OR FAULTY ECM.
CHECK FOR SHORT IN WIRE 419 BETWEEN J2-31 AND DLC TERMINAL E
IS THE 10 AND 15 AMP ECM FUSE OK?
YES
NO
4
DOES THE ENGINE CRANK?
LOCATE AND CORRECT SHORT TO GROUND IN CIRCUIT.
YES
NO
1
IGNITION “OFF.”
DISCONNECT ECM CONNECTORS.
IGNITION “ON.”
PROBE ECM CONNECTOR PINS J1-16, J1-32, AND J1-11 WITH TEST LIGHT TO GROUND.
IS THE LIGHT “ON,” ON ALL CIRCUITS?
PERFORM TESTS ON STARTING SYSTEM CIRCUIT. SEE TROUBLESHOOTING IN SECTION 1C.
YES
NO
FAULTY ECM GROUNDS OR ECM.
PERFORM EFI SYSTEM RELAY CHECK. DOES ENGINE START?
YES
NO
REPEAT STEP 1 OF THIS CHART
REPAIR OPEN IN CIRCUIT THAT DID NOT LIGHT THE TEST LIGHT.

Index

No DLC Data or Will Not Flash Code 12 “Malfunction Indicator Lamp” On Steady (Marine Diagnostic Code Tool Installed)
Chart A-2 (1 of 2)



CIRCUIT DESCRIPTION:

There should always be a steady “Malfunction Indicator Lamp” when the ignition is ON and engine stopped. Ignition voltage is supplied to the light bulb. The Engine Control Module (ECM) will turn the lamp ON by grounding CKT 419 in the ECM.

With the diagnostic “test” terminal grounded CKT 419, the lamp should flash a Code 12, followed by any trouble code(s) stored in memory.

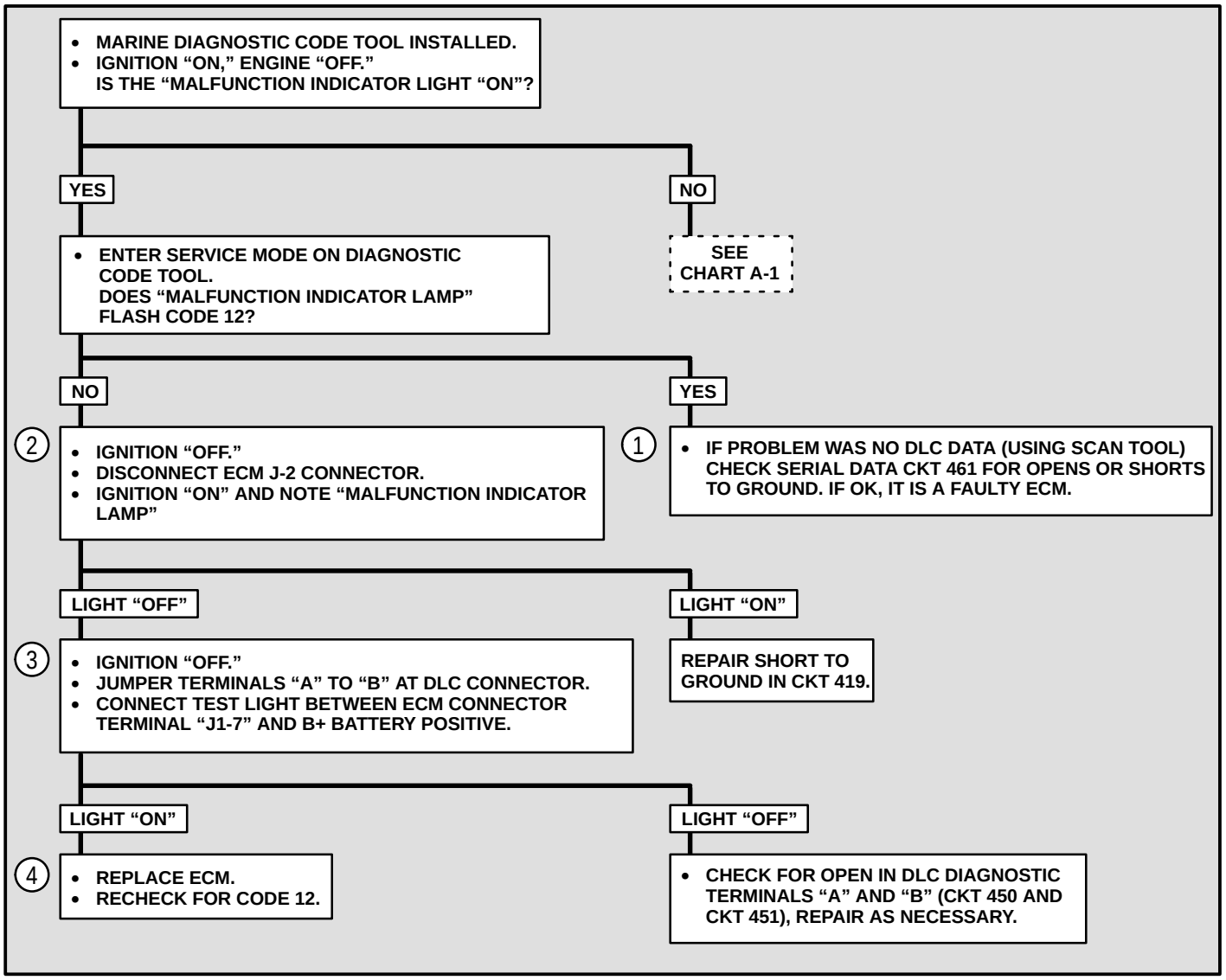
A steady light suggests a short to ground in the lamp control CKT 419 or an open in diagnostic CKT 451.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

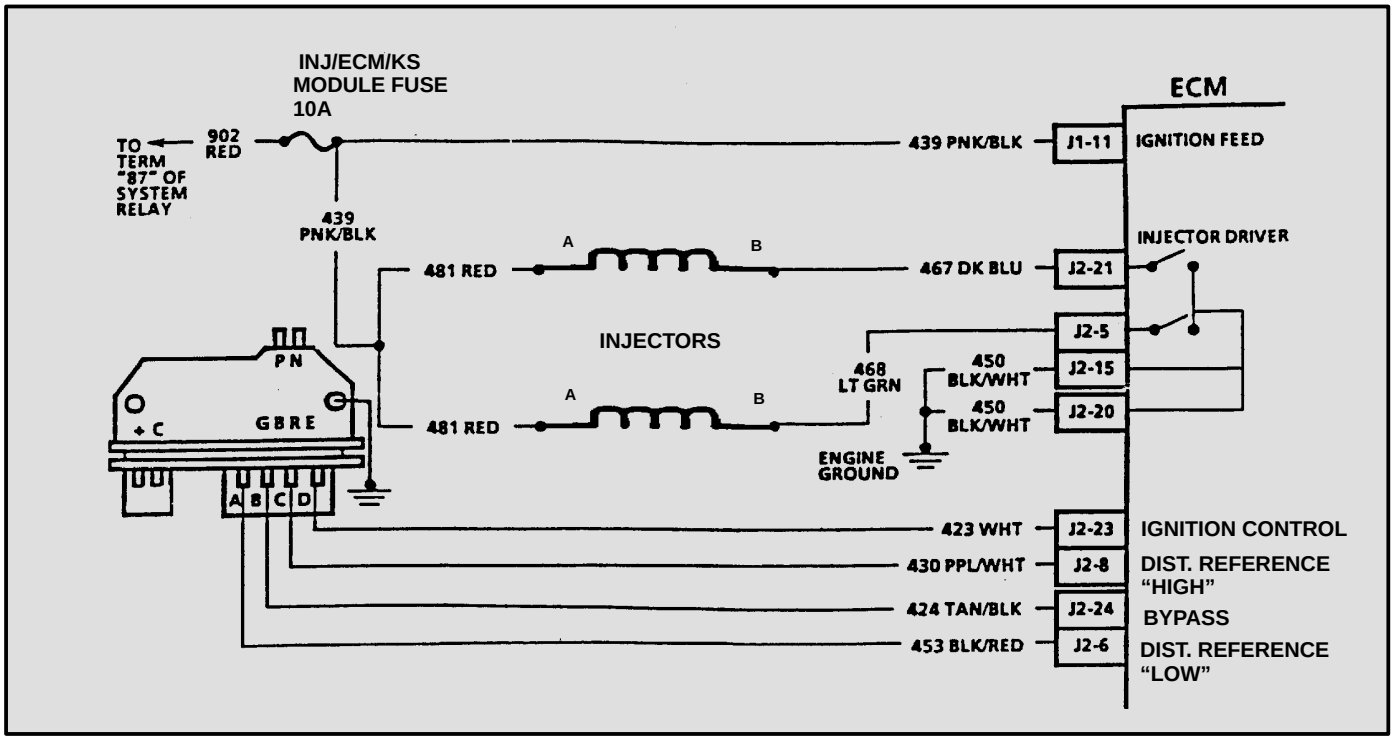
1. If there is a problem with the ECM that causes a scan tool to not read serial data, the ECM should not flash a Code 12. If Code 12 is flashing, check CKT 451 for short to ground. If Code 12 does flash, make sure that the scan tool is working properly on another engine.
2. If the light goes OFF when the ECM connector is disconnected, CKT 419 is not shorted to ground.
3. This step will check for an open diagnostic CKT 451.
4. At this point, the “Malfunction Indicator Lamp” wiring is OK. If Code 12 does not flash, the ECM should be replaced.

No DLC Data or Will Not Flash Code 12
Chart A-2: (2 of 2)


• MARINE DIAGNOSTIC CODE TOOL INSTALLED.
• IGNITION "ON," ENGINE "OFF."
IS THE "MALFUNCTION INDICATOR LIGHT "ON"?
YES
NO
• ENTER SERVICE MODE ON DIAGNOSTIC CODE TOOL.
DOES "MALFUNCTION INDICATOR LAMP" FLASH CODE 12?
SEE CHART A-1
NO
YES
2
• IGNITION "OFF."
• DISCONNECT ECM J-2 CONNECTOR.
• IGNITION "ON" AND NOTE "MALFUNCTION INDICATOR LAMP"
1
• IF PROBLEM WAS NO DLC DATA (USING SCAN TOOL) CHECK SERIAL DATA CKT 461 FOR OPENS OR SHORTS TO GROUND. IF OK, IT IS A FAULTY ECM.
LIGHT "OFF"
LIGHT "ON"
3
• IGNITION "OFF."
• JUMPER TERMINALS "A" TO "B" AT DLC CONNECTOR.
• CONNECT TEST LIGHT BETWEEN ECM CONNECTOR TERMINAL "J1-7" AND B+ BATTERY POSITIVE.
REPAIR SHORT TO GROUND IN CKT 419.
LIGHT "ON"
LIGHT "OFF"
4
• REPLACE ECM.
• RECHECK FOR CODE 12.
• CHECK FOR OPEN IN DLC DIAGNOSTIC TERMINALS "A" AND "B" (CKT 450 AND CKT 451), REPAIR AS NECESSARY.

Index

Engine Cranks but Will Not Run Chart A-3 (1 of 4)



CIRCUIT DESCRIPTION:

This chart assumes that battery condition and engine cranking speed are OK, and there is adequate fuel in the tank.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. An ECT sensor that indicates coolant temperature less than actual temperature can flood the engine with fuel. An ECT sensor that indicates coolant temperature greater than actual can starve the engine of fuel. If the TP sensor is at 50 to 75% of its range, the engine may be in the clear flood mode, which will cause starting problems. The engine will not start without reference pulses and, therefore, the scan tool should read engine RPM (reference) during cranking.
2. No spark may be caused by one of several components related to the high energy ignition/IC system. The ignition system will address all problems related to the causes of a no spark condition.
3. The test light should blink, indicating the ECM is controlling the injectors OK.
4. All injectors should be within 1.0 ohm of each other and should not be less than 12 ohms at 70°F (21°C). If an injector is suspected for a no start condition, unhook the suspected injector and try to start the engine.
5. Use fuel pressure gauge 91-16850 or J-34730-1. Wrap a shop towel around the fuel pressure tap to absorb any small amount of fuel leakage that may occur when installing the gauge.

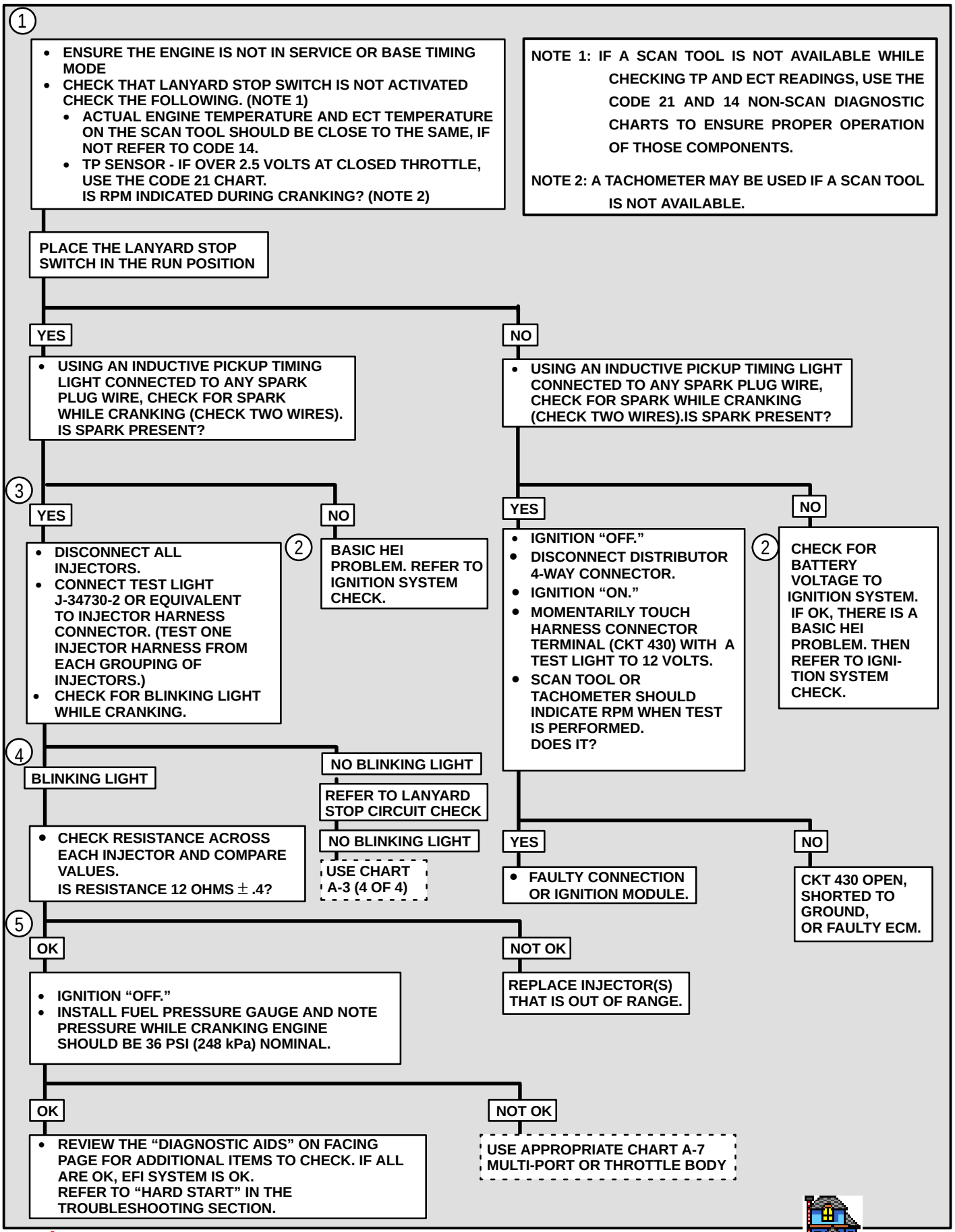
DIAGNOSTIC AIDS:

- Unless engine enters "Clear Flood" at the first indication of a flooding condition, it can result in a no start.
- Check for fouled plugs.
- Water or foreign material in fuel line, VST, water separating fuel filter can cause a no start in cold weather.
- A defective MAP sensor may cause a no start or a stall after start. To determine if the sensor is causing the problem, disconnect it. The ECM will then use a default value for the sensor, and if the condition is corrected and the connections are OK, replace the sensor.
- Using injector harness test light (J-34730-2A) check for blinking light at injector harness on both banks of the engine. If not OK, check injector fuses.

If above are all OK, refer to "Troublesho

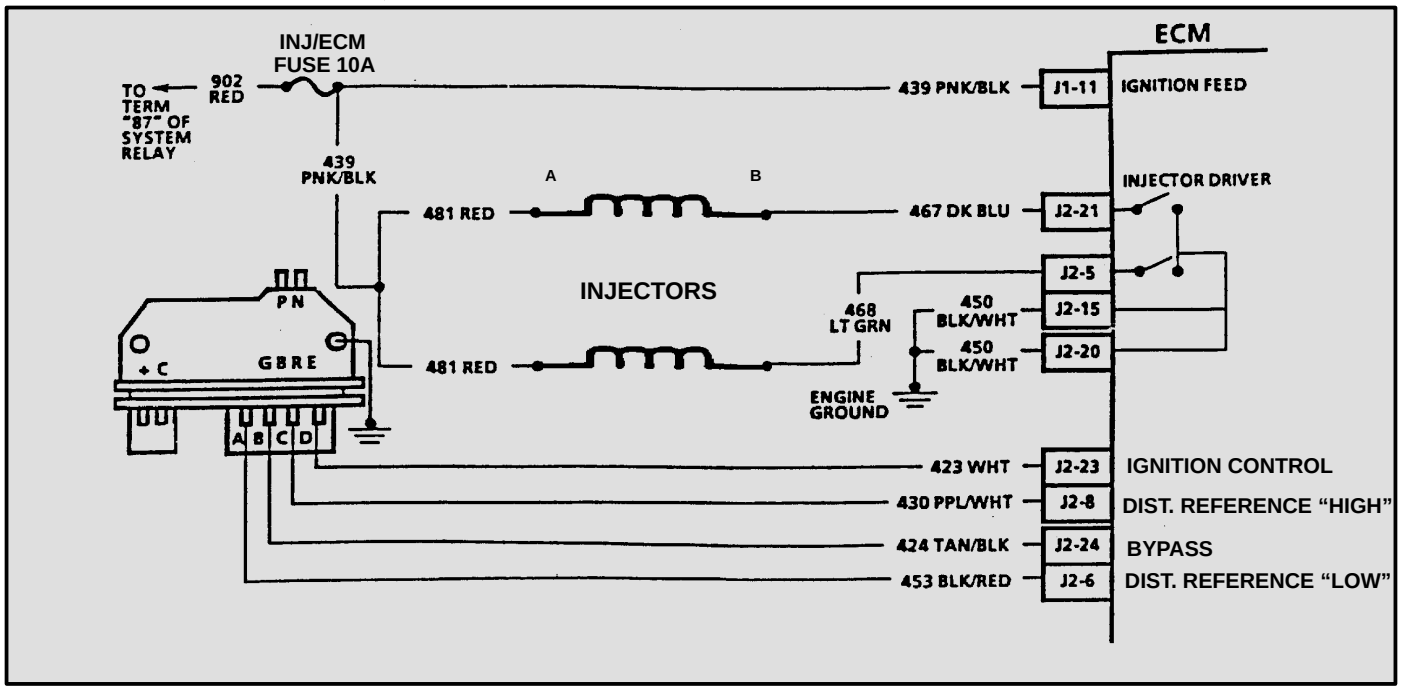
Index

Engine Cranks but Will Not Run (Continued)
Chart A-3: (2 of 4)


1
ENSURE THE ENGINE IS NOT IN SERVICE OR BASE TIMING MODE
CHECK THAT LANYARD STOP SWITCH IS NOT ACTIVATED CHECK THE FOLLOWING. (NOTE 1)
ACTUAL ENGINE TEMPERATURE AND ECT TEMPERATURE ON THE SCAN TOOL SHOULD BE CLOSE TO THE SAME, IF NOT REFER TO CODE 14.
TP SENSOR - IF OVER 2.5 VOLTS AT CLOSED THROTTLE, USE THE CODE 21 CHART.
IS RPM INDICATED DURING CRANKING? (NOTE 2)
NOTE 1: IF A SCAN TOOL IS NOT AVAILABLE WHILE CHECKING TP AND ECT READINGS, USE THE CODE 21 AND 14 NON-SCAN DIAGNOSTIC CHARTS TO ENSURE PROPER OPERATION OF THOSE COMPONENTS.
NOTE 2: A TACHOMETER MAY BE USED IF A SCAN TOOL IS NOT AVAILABLE.
PLACE THE LANYARD STOP SWITCH IN THE RUN POSITION
YES
NO
USING AN INDUCTIVE PICKUP TIMING LIGHT CONNECTED TO ANY SPARK PLUG WIRE, CHECK FOR SPARK WHILE CRANKING (CHECK TWO WIRES). IS SPARK PRESENT?
USING AN INDUCTIVE PICKUP TIMING LIGHT CONNECTED TO ANY SPARK PLUG WIRE, CHECK FOR SPARK WHILE CRANKING (CHECK TWO WIRES).IS SPARK PRESENT?
3
YES
NO
DISCONNECT ALL INJECTORS.
CONNECT TEST LIGHT J-34730-2 OR EQUIVALENT TO INJECTOR HARNESS CONNECTOR. (TEST ONE INJECTOR HARNESS FROM EACH GROUPING OF INJECTORS.)
CHECK FOR BLINKING LIGHT WHILE CRANKING.
2
BASIC HEI PROBLEM. REFER TO IGNITION SYSTEM CHECK.
YES
NO
IGNITION "OFF."
DISCONNECT DISTRIBUTOR 4-WAY CONNECTOR.
IGNITION "ON."
MOMENTARILY TOUCH HARNESS CONNECTOR TERMINAL (CKT 430) WITH A TEST LIGHT TO 12 VOLTS.
SCAN TOOL OR TACHOMETER SHOULD INDICATE RPM WHEN TEST IS PERFORMED.
DOES IT?
2
CHECK FOR BATTERY VOLTAGE TO IGNITION SYSTEM. IF OK, THERE IS A BASIC HEI PROBLEM. THEN REFER TO IGNITION SYSTEM CHECK.
4
BLINKING LIGHT
NO BLINKING LIGHT
REFER TO LANYARD STOP CIRCUIT CHECK
NO BLINKING LIGHT
USE CHART A-3 (4 OF 4)
CHECK RESISTANCE ACROSS EACH INJECTOR AND COMPARE VALUES.
IS RESISTANCE 12 OHMS ± .4?
YES
NO
FAULTY CONNECTION OR IGNITION MODULE.
CKT 430 OPEN, SHORTED TO GROUND, OR FAULTY ECM.
5
OK
NOT OK
IGNITION "OFF."
INSTALL FUEL PRESSURE GAUGE AND NOTE PRESSURE WHILE CRANKING ENGINE SHOULD BE 36 PSI (248 kPa) NOMINAL.
REPLACE INJECTOR(S) THAT IS OUT OF RANGE.
OK
NOT OK
REVIEW THE "DIAGNOSTIC AIDS" ON FACING PAGE FOR ADDITIONAL ITEMS TO CHECK. IF ALL ARE OK, EFI SYSTEM IS OK.
REFER TO "HARD START" IN THE TROUBLESHOOTING SECTION.
USE APPROPRIATE CHART A-7 MULTI-PORT OR THROTTLE BODY

Index

Engine Cranks but Will Not Run (Continued)
Chart A-3 (3 of 4)



TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

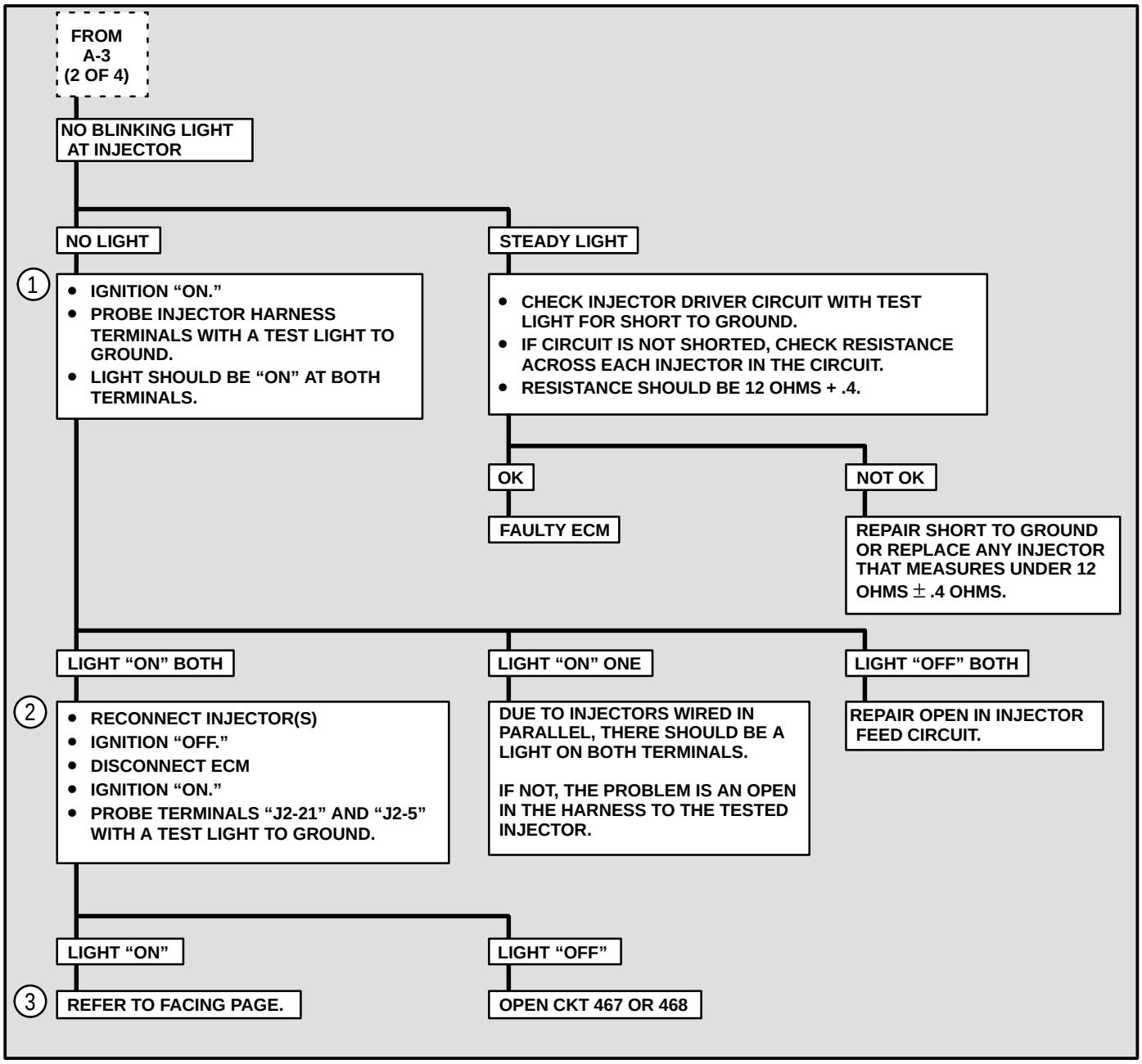
1. Check for 12 volt supply to injectors. Due to the injectors wired in parallel, there should be a light ON on both terminals.
2. Check continuity of CKT 467 and CKT 468.
3. All checks made to this point would indicate that the ECM is at fault. However, there is a possibility of CKT 467 or CKT 468 being shorted to a voltage source either in the engine harness or in the injector harness.

To test for this condition:

- Disconnect all injectors.
- Ignition ON.
- Probe CKT 467 and CKT 468 on the ECM side of injector harness with a test light connected to ground. (Test one injector harness on each side of engine.) There should be no light. If light is ON, repair short to voltage.
- If OK, check the resistance of the injectors. Should be 12 ohms $\pm$ 4.
- Check injector harness connector. Be sure terminals are not backed out of connector and contacting each other.
- If all OK, replace ECM.

Index

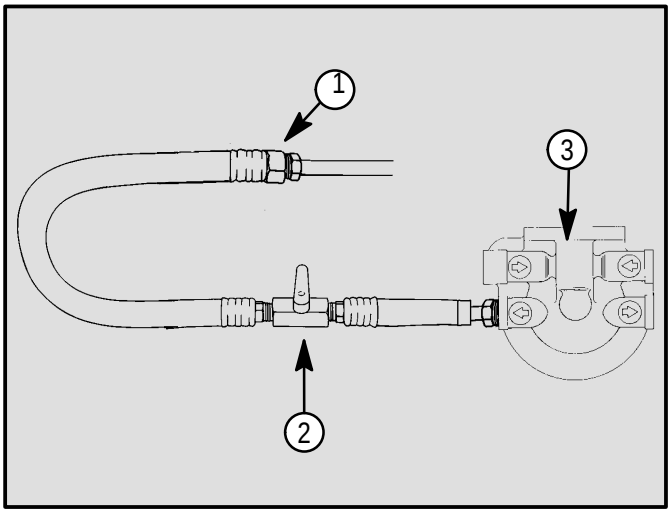
Engine Cranks but Will Not Run (Continued)
Chart A-3: (4 of 4)


FROM A-3 (2 OF 4)
NO BLINKING LIGHT AT INJECTOR
NO LIGHT
STEADY LIGHT
1
IGNITION "ON."
PROBE INJECTOR HARNESS TERMINALS WITH A TEST LIGHT TO GROUND.
LIGHT SHOULD BE "ON" AT BOTH TERMINALS.
CHECK INJECTOR DRIVER CIRCUIT WITH TEST LIGHT FOR SHORT TO GROUND.
IF CIRCUIT IS NOT SHORTED, CHECK RESISTANCE ACROSS EACH INJECTOR IN THE CIRCUIT.
RESISTANCE SHOULD BE 12 OHMS + .4.
OK
NOT OK
FAULTY ECM
REPAIR SHORT TO GROUND OR REPLACE ANY INJECTOR THAT MEASURES UNDER 12 OHMS ± .4 OHMS.
LIGHT "ON" BOTH
LIGHT "ON" ONE
LIGHT "OFF" BOTH
2
RECONNECT INJECTOR(S)
IGNITION "OFF."
DISCONNECT ECM
IGNITION "ON."
PROBE TERMINALS "J2-21" AND "J2-5" WITH A TEST LIGHT TO GROUND.
DUE TO INJECTORS WIRED IN PARALLEL, THERE SHOULD BE A LIGHT ON BOTH TERMINALS.
IF NOT, THE PROBLEM IS AN OPEN IN THE HARNESS TO THE TESTED INJECTOR.
REPAIR OPEN IN INJECTOR FEED CIRCUIT.
LIGHT "ON"
LIGHT "OFF"
3
REFER TO FACING PAGE.
OPEN CKT 467 OR 468

Index

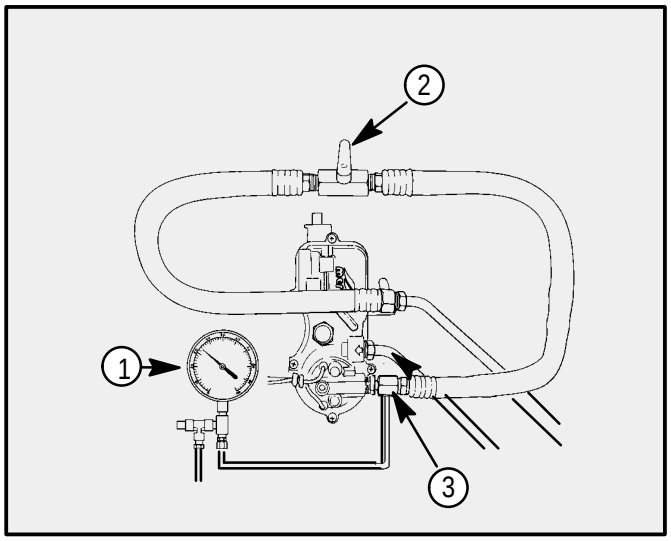
Fuel System Diagnosis Chart A-7 (1 of 6)

COOL FUEL SYSTEM



1 - Fuel Line To Electric Fuel Pump
2 - Shut Off Tool
3 - Water Separating Fuel Filter

VAPOR SEPARATOR TANK (VST) SYSTEM



1 - Fuel Pressure Gauge (91-16850)
2 - Fuel Shut Off Tool (91-16850)
3 - Fuel Fitting Connector (91-806901) Installed On The Pressure Line

IMPORTANT: Check for contaminated fuel tank, stuck anti siphon valve or fuel system vacuum leak anywhere before the electrical fuel pump and after the fuel pressure regulator.

CIRCUIT DESCRIPTION:

During engine cranking, the Engine Control Module (ECM) will turn ON the electric fuel pump. It will remain ON as long as the engine is cranking or running, and the ECM is receiving reference pulses. If there are no reference pulses, the ECM will shut OFF the fuel pump.

The pump will deliver fuel to the injectors and pressure regulator, where the system pressure is controlled to about 30 PSI (207 kPa) nominal. Excess fuel is then returned to the water separating fuel filter.

TEST DESCRIPTION:

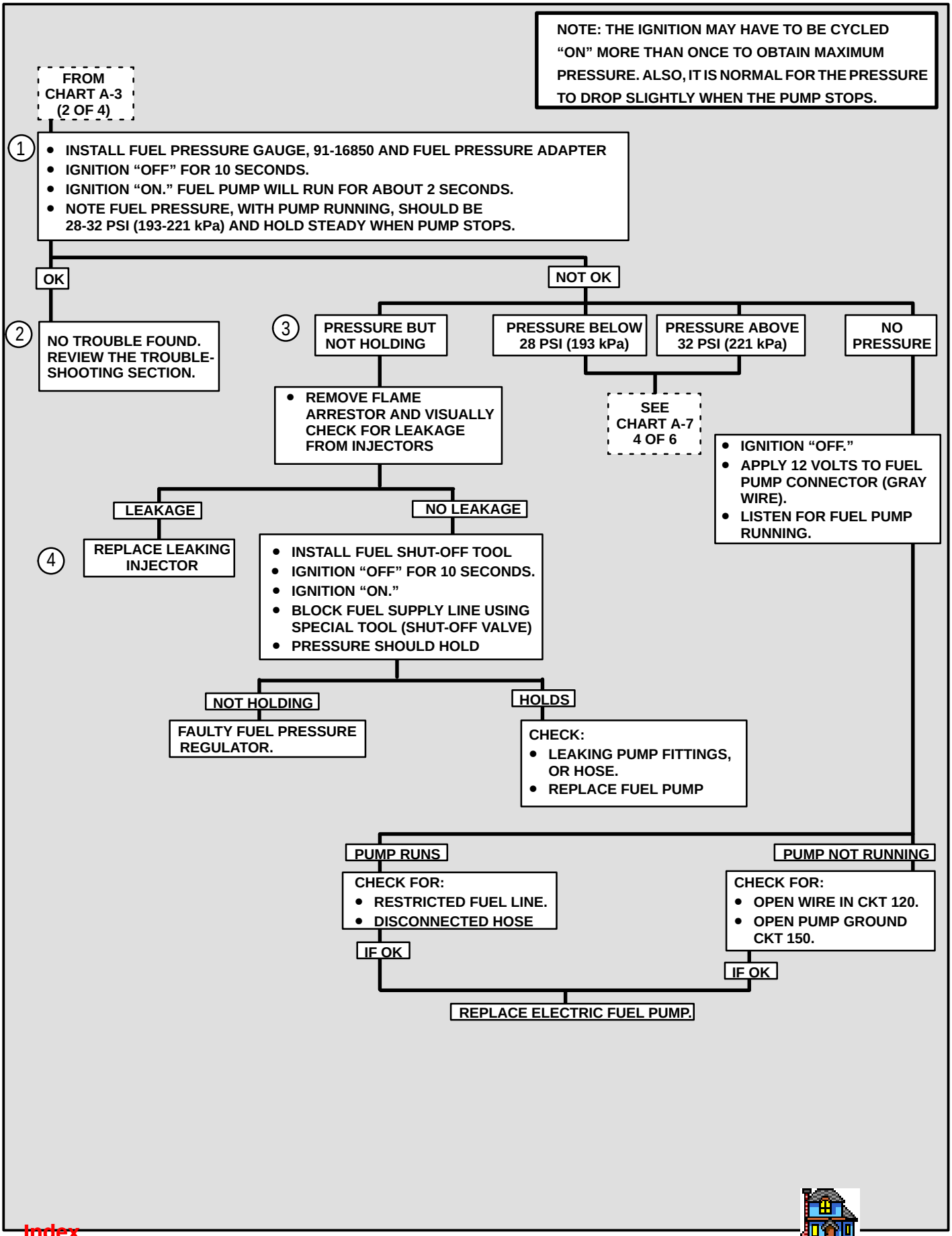
Number(s) below refer to circled number(s) on the diagnostic chart.

NOTE: *If pump does not run, check fuel pump relay and fuse.*

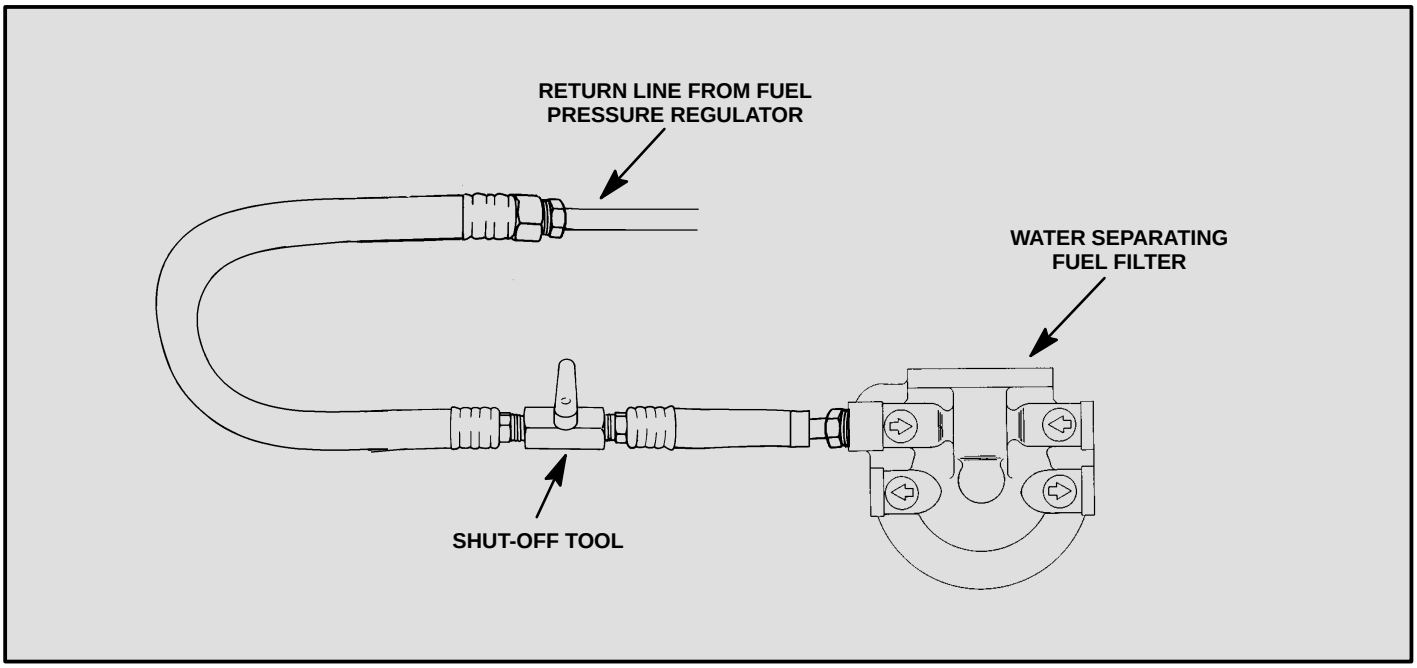
1. Install the fuel pressure adapter in-line at the throttle body.
2. Wrap a shop towel around the fuel pressure connector to absorb any small amount of fuel leakage that may occur when installing the gauge.

   Ignition ON, pump pressure should be 28-32 PSI (234-207 kPa). This pressure is controlled by spring pressure within the regulator assembly.
3. Pressure that leaks down is caused by one of the following:
   - Fuel pressure regulator valve leaking.
   - Injector(s) sticking open.
   - Check valve in fuel pump leaking.
4. An injector that is stuck open will leak or drip fuel into the plenum of intake manifold, which may saturate or foul spark plug(s). In order to determine which injector is leaking, remove the flame arrestor and observe both fuel injectors with ”key on” and ”engine off”.

Fuel System Diagnosis (Continued)
Chart A-7: (2 of 6)


NOTE: THE IGNITION MAY HAVE TO BE CYCLED "ON" MORE THAN ONCE TO OBTAIN MAXIMUM PRESSURE. ALSO, IT IS NORMAL FOR THE PRESSURE TO DROP SLIGHTLY WHEN THE PUMP STOPS.
FROM CHART A-3 (2 OF 4)
1
INSTALL FUEL PRESSURE GAUGE, 91-16850 AND FUEL PRESSURE ADAPTER
IGNITION "OFF" FOR 10 SECONDS.
IGNITION "ON." FUEL PUMP WILL RUN FOR ABOUT 2 SECONDS.
NOTE FUEL PRESSURE, WITH PUMP RUNNING, SHOULD BE 28-32 PSI (193-221 kPa) AND HOLD STEADY WHEN PUMP STOPS.
OK
NOT OK
2
NO TROUBLE FOUND. REVIEW THE TROUBLE-SHOOTING SECTION.
3
PRESSURE BUT NOT HOLDING
PRESSURE BELOW 28 PSI (193 kPa)
PRESSURE ABOVE 32 PSI (221 kPa)
NO PRESSURE
REMOVE FLAME ARRESTOR AND VISUALLY CHECK FOR LEAKAGE FROM INJECTORS
SEE CHART A-7 4 OF 6
IGNITION "OFF."
APPLY 12 VOLTS TO FUEL PUMP CONNECTOR (GRAY WIRE).
LISTEN FOR FUEL PUMP RUNNING.
LEAKAGE
NO LEAKAGE
4
REPLACE LEAKING INJECTOR
INSTALL FUEL SHUT-OFF TOOL
IGNITION "OFF" FOR 10 SECONDS.
IGNITION "ON."
BLOCK FUEL SUPPLY LINE USING SPECIAL TOOL (SHUT-OFF VALVE)
PRESSURE SHOULD HOLD
NOT HOLDING
HOLDS
FAULTY FUEL PRESSURE REGULATOR.
CHECK:
LEAKING PUMP FITTINGS, OR HOSE.
REPLACE FUEL PUMP
PUMP RUNS
PUMP NOT RUNNING
CHECK FOR:
RESTRICTED FUEL LINE.
DISCONNECTED HOSE
CHECK FOR:
OPEN WIRE IN CKT 120.
OPEN PUMP GROUND CKT 150.
IF OK
IF OK
REPLACE ELECTRIC FUEL PUMP.

Fuel System Diagnosis (Continued)
Chart A-7 (3 of 6)



IMPORTANT: Check for contaminated fuel tank, stuck anti-siphon valve or fuel system vacuum leak anywhere before the electrical fuel pump and after the fuel pressure regulator.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Pressure less than 28 PSI (193 kPa) falls into two areas:

- Regulated pressure less than 28 PSI (193 kPa). The system will be running lean. Also, hard starting when cold and overall poor performance will be noticed.
- Restricted flow causing pressure drop. Normally, an engine with a fuel pressure of less than 24 PSI (165 kPa) at idle will not be driveable. However, if the pressure drop occurs only while underway, the engine will surge then stop running as pressure begins to drop rapidly. This is most likely caused by a restricted fuel line or plugged water separating fuel filter.

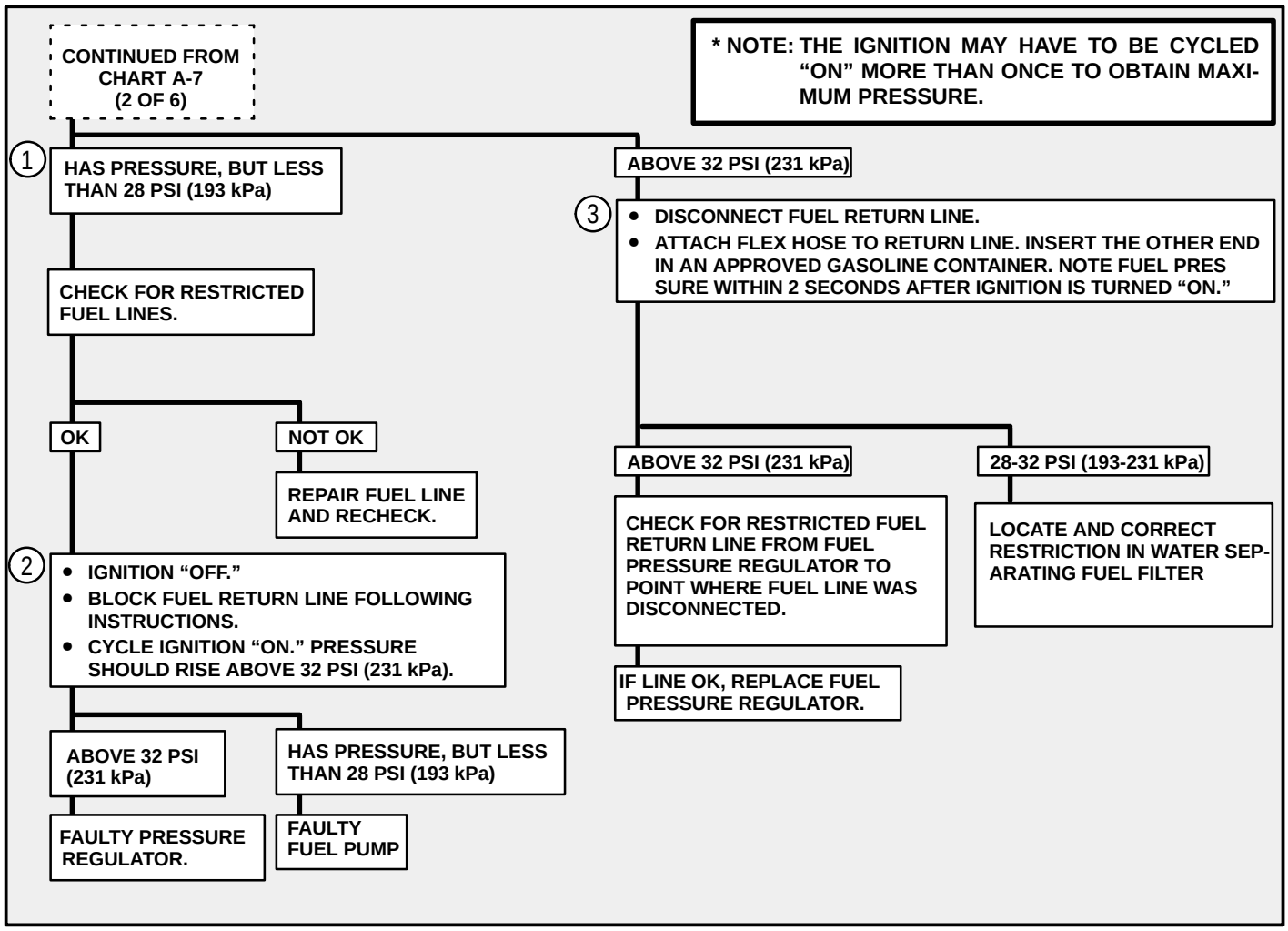
2. Restricting the fuel return line (Shut-Off Valve) allows the fuel pressure to build above regulated pressure. With battery voltage applied to the fuel pump, pressure should rise to 60 PSI (414 kPa) as the fuel return hose is shut off with special tool.

NOTE: *Do not allow fuel pressure to exceed 60 PSI (414 kPa); damage to the pressure regulator may result.*

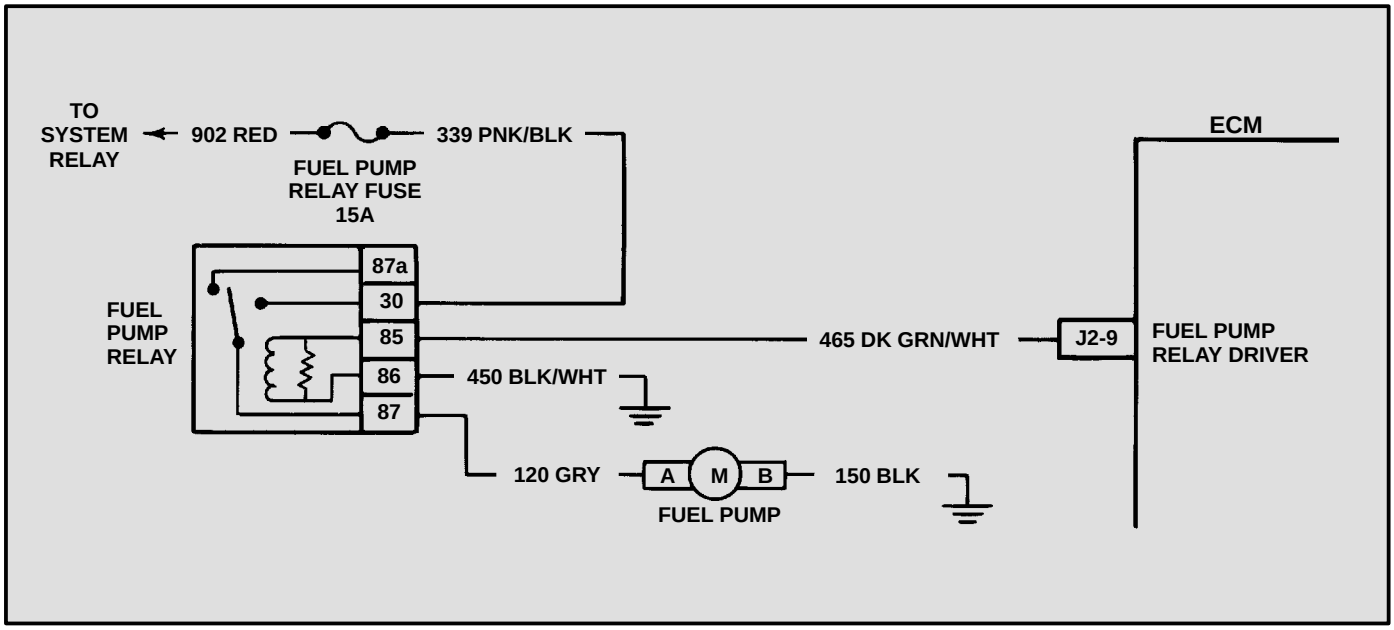
3. This test determines if the high fuel pressure is due to a restricted fuel return line or a pressure regulator problem.

Index

Fuel System Diagnosis (Continued)
Chart A-7: (4 of 6)


CONTINUED FROM CHART A-7 (2 OF 6)
* NOTE: THE IGNITION MAY HAVE TO BE CYCLED "ON" MORE THAN ONCE TO OBTAIN MAXIMUM PRESSURE.
1
HAS PRESSURE, BUT LESS THAN 28 PSI (193 kPa)
CHECK FOR RESTRICTED FUEL LINES.
OK
NOT OK
REPAIR FUEL LINE AND RECHECK.
2
IGNITION "OFF."
BLOCK FUEL RETURN LINE FOLLOWING INSTRUCTIONS.
CYCLE IGNITION "ON." PRESSURE SHOULD RISE ABOVE 32 PSI (231 kPa).
ABOVE 32 PSI (231 kPa)
FAULTY PRESSURE REGULATOR.
HAS PRESSURE, BUT LESS THAN 28 PSI (193 kPa)
FAULTY FUEL PUMP
ABOVE 32 PSI (231 kPa)
3
DISCONNECT FUEL RETURN LINE.
ATTACH FLEX HOSE TO RETURN LINE. INSERT THE OTHER END IN AN APPROVED GASOLINE CONTAINER. NOTE FUEL PRESSURE WITHIN 2 SECONDS AFTER IGNITION IS TURNED "ON."
ABOVE 32 PSI (231 kPa)
CHECK FOR RESTRICTED FUEL RETURN LINE FROM FUEL PRESSURE REGULATOR TO POINT WHERE FUEL LINE WAS DISCONNECTED.
IF LINE OK, REPLACE FUEL PRESSURE REGULATOR.
28-32 PSI (193-231 kPa)
LOCATE AND CORRECT RESTRICTION IN WATER SEPARATING FUEL FILTER

Fuel System Diagnosis (Continued)
Chart A-7 (5 of 6)

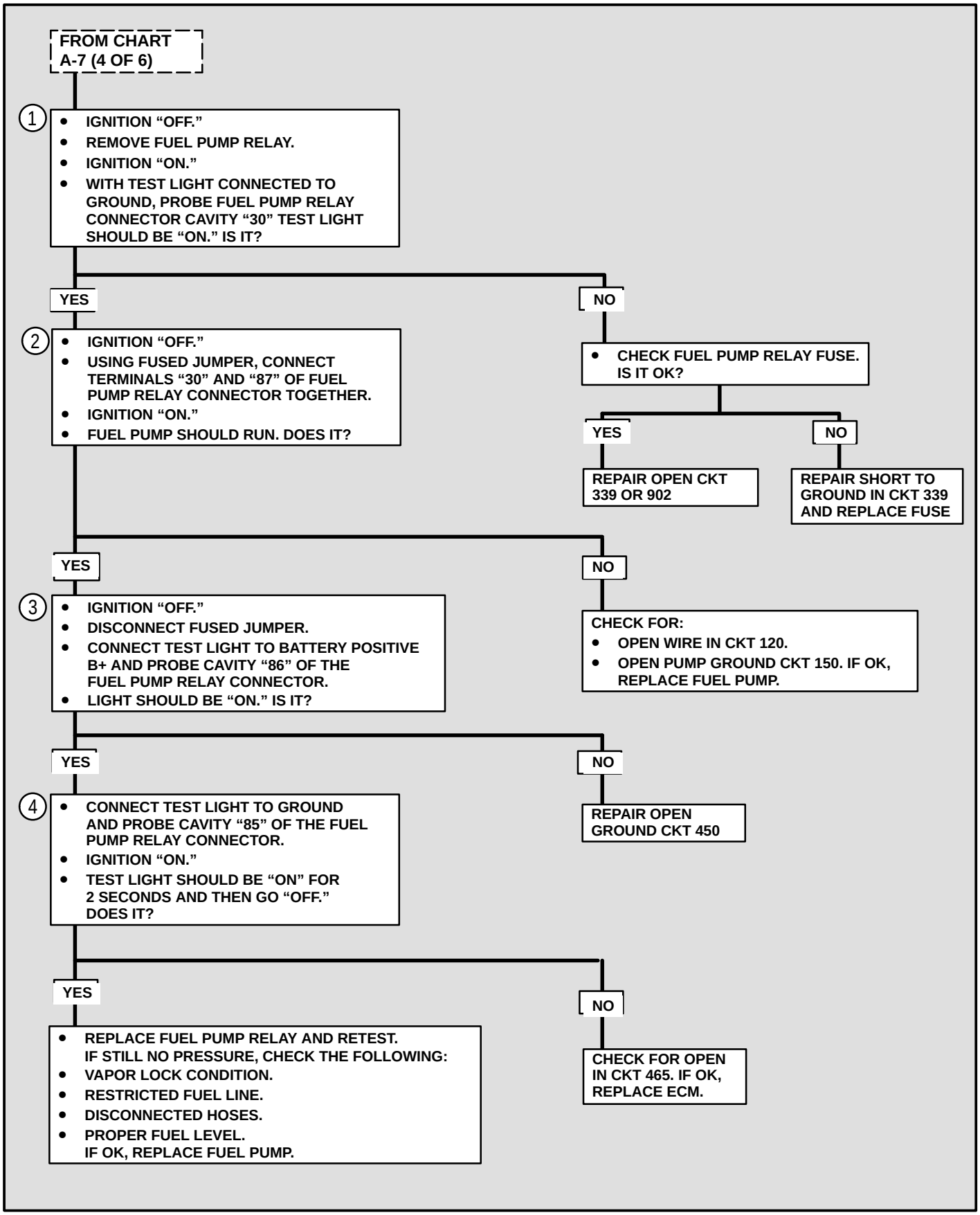


TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

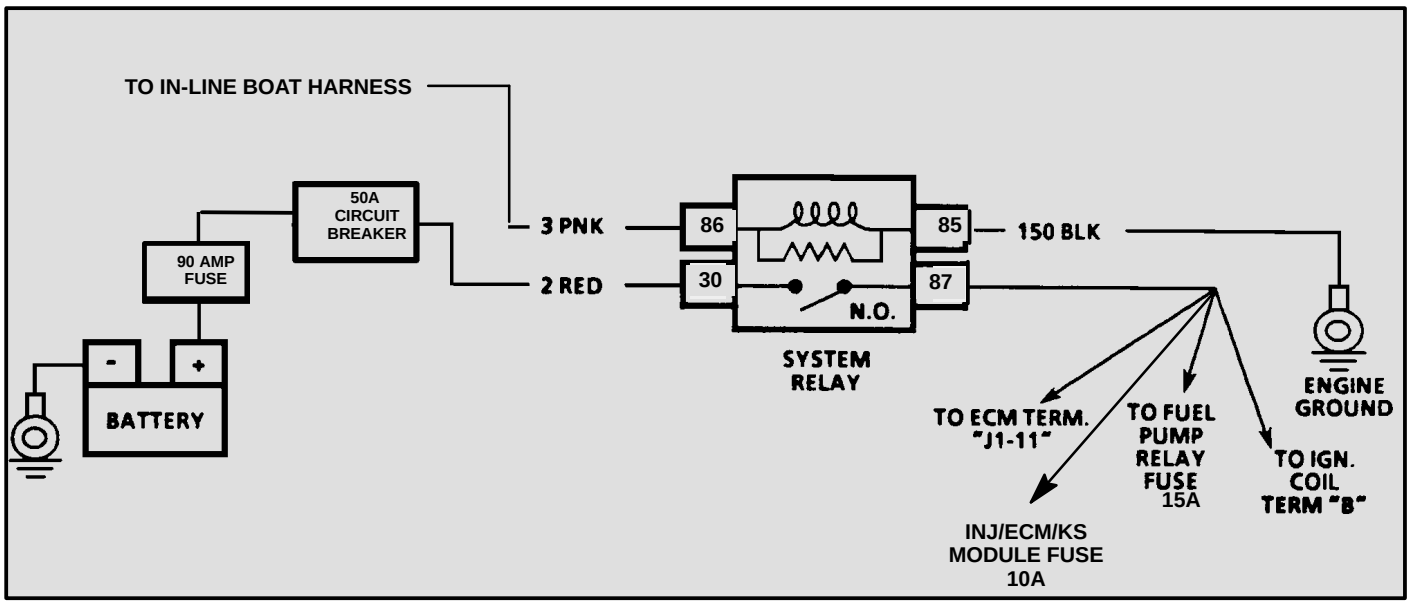
1. This step checks if there is power to the fuel pump relay.
2. Bypassing the relay circuit should cause the fuel pump to run. This step should identify if the fault is in the relay or in the fuel pump circuit.
3. This step checks if there is an open in the ground circuit.
4. This step checks if the ECM is functioning properly.

Fuel System Diagnosis (Continued)
Chart A-7: (6 of 6)


FROM CHART A-7 (4 OF 6)
1
IGNITION "OFF."
REMOVE FUEL PUMP RELAY.
IGNITION "ON."
WITH TEST LIGHT CONNECTED TO GROUND, PROBE FUEL PUMP RELAY CONNECTOR CAVITY "30" TEST LIGHT SHOULD BE "ON." IS IT?
YES
NO
2
IGNITION "OFF."
USING FUSED JUMPER, CONNECT TERMINALS "30" AND "87" OF FUEL PUMP RELAY CONNECTOR TOGETHER.
IGNITION "ON."
FUEL PUMP SHOULD RUN. DOES IT?
CHECK FUEL PUMP RELAY FUSE. IS IT OK?
YES
NO
REPAIR OPEN CKT 339 OR 902
REPAIR SHORT TO GROUND IN CKT 339 AND REPLACE FUSE
YES
NO
3
IGNITION "OFF."
DISCONNECT FUSED JUMPER.
CONNECT TEST LIGHT TO BATTERY POSITIVE B+ AND PROBE CAVITY "86" OF THE FUEL PUMP RELAY CONNECTOR.
LIGHT SHOULD BE "ON." IS IT?
CHECK FOR:
OPEN WIRE IN CKT 120.
OPEN PUMP GROUND CKT 150. IF OK, REPLACE FUEL PUMP.
YES
NO
4
CONNECT TEST LIGHT TO GROUND AND PROBE CAVITY "85" OF THE FUEL PUMP RELAY CONNECTOR.
IGNITION "ON."
TEST LIGHT SHOULD BE "ON" FOR 2 SECONDS AND THEN GO "OFF." DOES IT?
REPAIR OPEN GROUND CKT 450
YES
NO
REPLACE FUEL PUMP RELAY AND RETEST. IF STILL NO PRESSURE, CHECK THE FOLLOWING:
VAPOR LOCK CONDITION.
RESTRICTED FUEL LINE.
DISCONNECTED HOSES.
PROPER FUEL LEVEL.
IF OK, REPLACE FUEL PUMP.
CHECK FOR OPEN IN CKT 465. IF OK, REPLACE ECM.

Index

EFI System/Ignition Relay Check
(1 of 2)



CIRCUIT DESCRIPTION:

Battery voltage is constantly supplied to terminal 30 of the system relay. When the ignition switch is moved to the run position, battery voltage is supplied to terminal 86 of the system relay. The pull-in coil is then energized, creating a magnetic field which closes the contacts of the system relay. Voltage and current are then supplied to the ignition coil, injectors, ECM and fuel pump relay fuse through terminal 87 of the system relay.

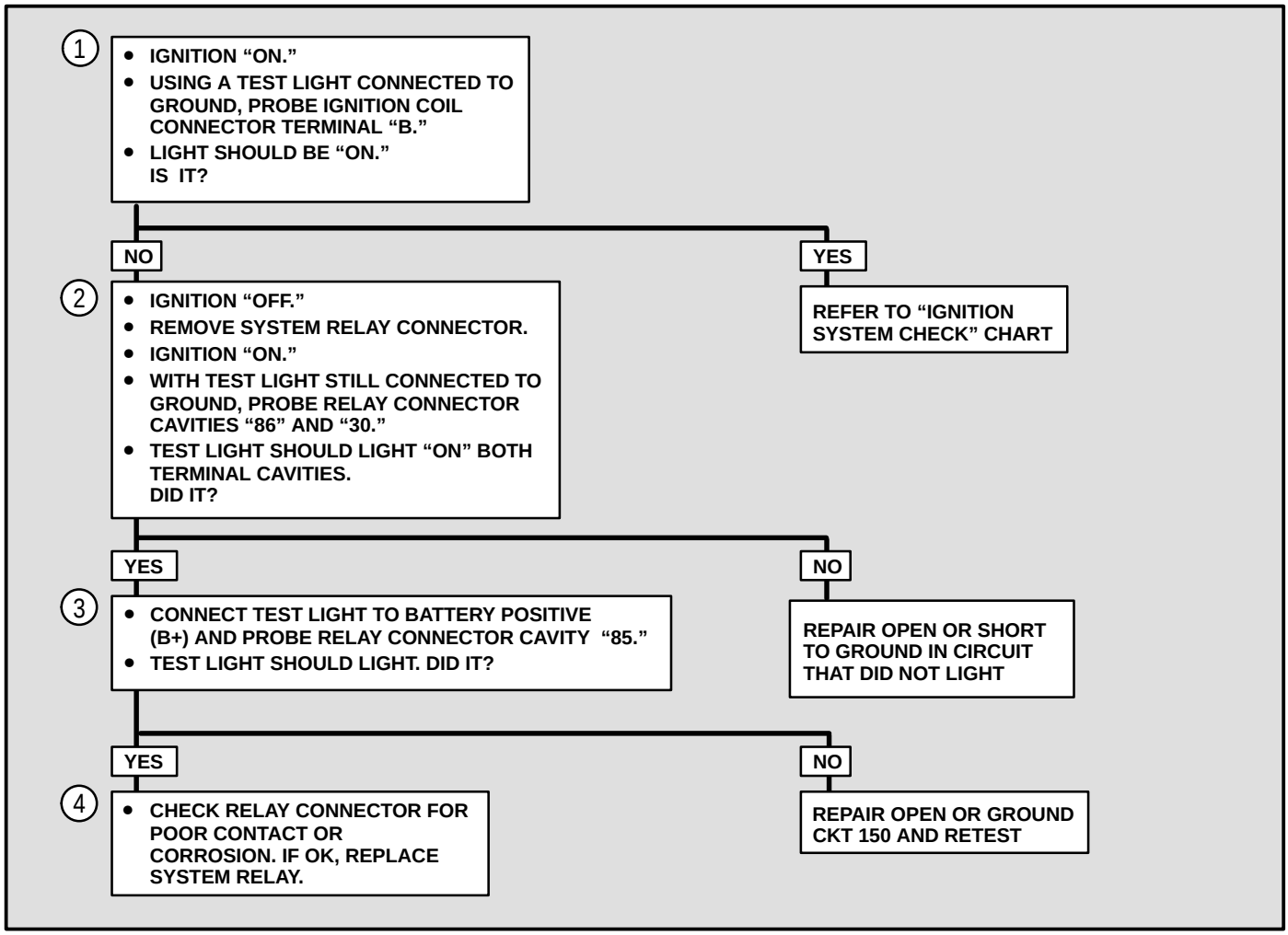
TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

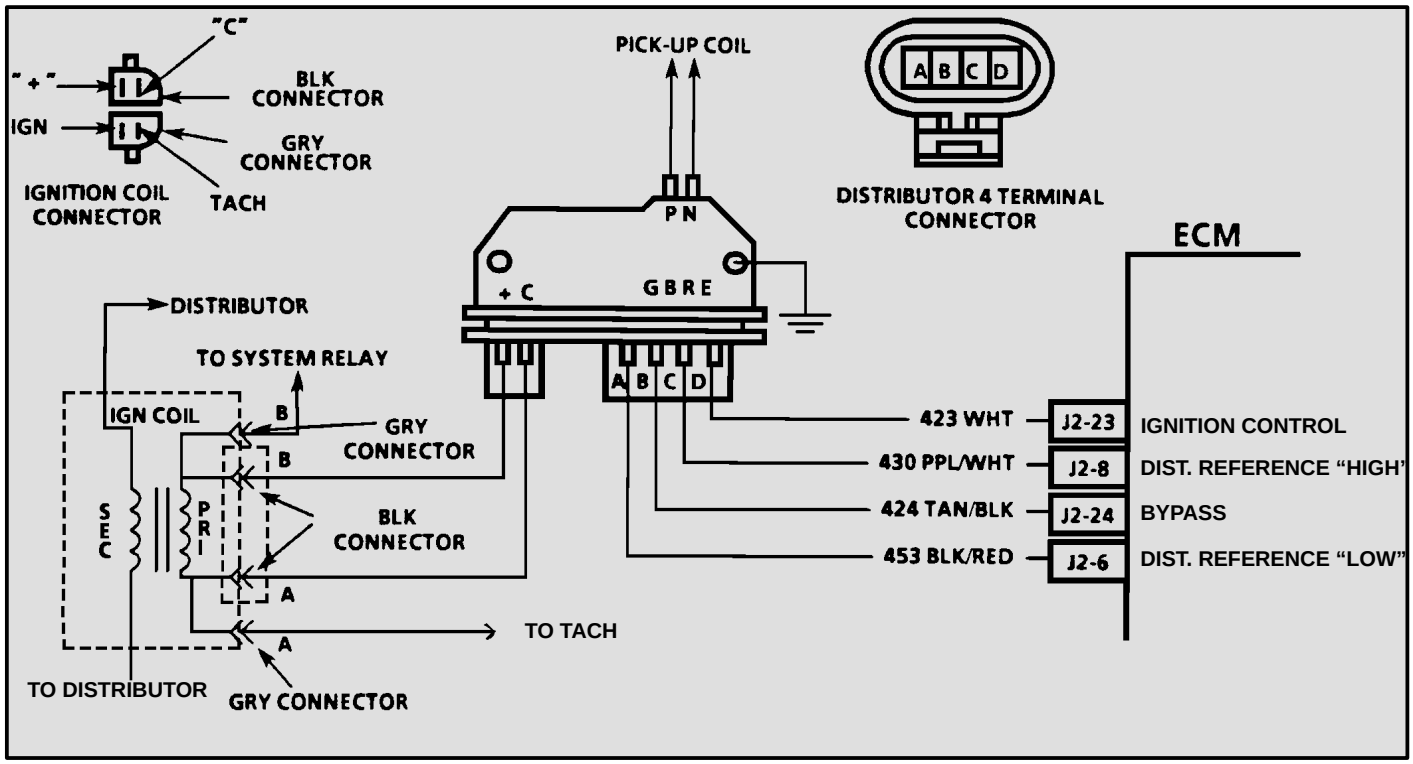
1. This step identifies if the relay is functioning properly. If a fault in the relay circuit were present, voltage would not be available at terminal B of the ignition coil.
2. This step ensures that battery and ignition voltage are available at the relay. An open or shorted condition in either supply would cause the relay not to operate.
3. This step ensures that a good ground exists to terminal 85 of the system relay. An open ground to this terminal would not allow current to flow through the pull-in coil.
4. At this point, the circuits leading to the relay have been checked, and a careful visual inspection of the relay terminals should be preformed prior to replacement of the system relay.

Index

EFI System / Ignition Relay Check (Continued)
(2 of 2)


1
IGNITION “ON.”
USING A TEST LIGHT CONNECTED TO GROUND, PROBE IGNITION COIL CONNECTOR TERMINAL “B.”
LIGHT SHOULD BE “ON.”
IS IT?
NO
YES
REFER TO “IGNITION SYSTEM CHECK” CHART
2
IGNITION “OFF.”
REMOVE SYSTEM RELAY CONNECTOR.
IGNITION “ON.”
WITH TEST LIGHT STILL CONNECTED TO GROUND, PROBE RELAY CONNECTOR CAVITIES “86” AND “30.”
TEST LIGHT SHOULD LIGHT “ON” BOTH TERMINAL CAVITIES.
DID IT?
YES
NO
REPAIR OPEN OR SHORT TO GROUND IN CIRCUIT THAT DID NOT LIGHT
3
CONNECT TEST LIGHT TO BATTERY POSITIVE (B+) AND PROBE RELAY CONNECTOR CAVITY “85.”
TEST LIGHT SHOULD LIGHT. DID IT?
YES
NO
REPAIR OPEN OR GROUND CKT 150 AND RETEST
4
CHECK RELAY CONNECTOR FOR POOR CONTACT OR CORROSION. IF OK, REPLACE SYSTEM RELAY.

Ignition System Check
(1 of 2)



TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Two spark plug wires are checked, to ensure that an open is not present in a spark plug wire.

   If spark occurs with Ignition Control (IC) connector disconnected, magnetic field output is too low for Ignition Control (IC) operation.

2. A spark indicates the problem must be the distributor cap or rotor.

3. Normally, there should be battery voltage at the "C" and "+" terminals. Low voltage would indicate an open or a high resistance circuit from the distributor to the coil or ignition switch. If "C" terminal voltage was low, but "+" terminal voltage is 10 volts or more, circuit from "C" terminal to ignition coil or ignition coil primary winding is open.

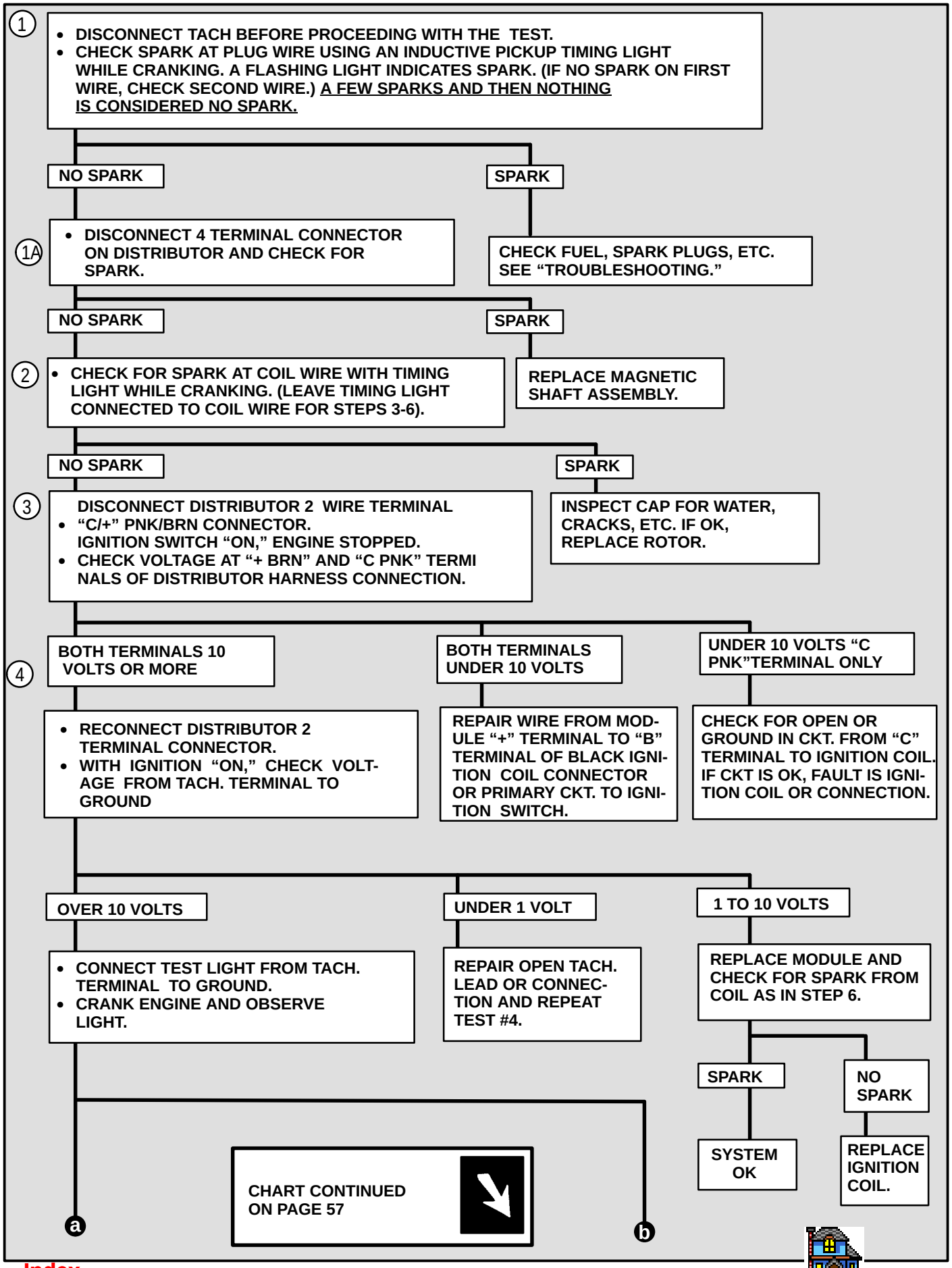
4. Checks for a shorted module or grounded circuit from the ignition coil to the module. The distributor module should be turned OFF, so normal voltage should be about 12 volts.

   If the module is turned ON, the voltage would be low, but above 1 volt. This could cause the ignition coil to fail from excessive heat.

   With an open ignition coil primary winding, a small amount of voltage will leak through the module from the Battery Positive (B+) to the "Tach" terminal.

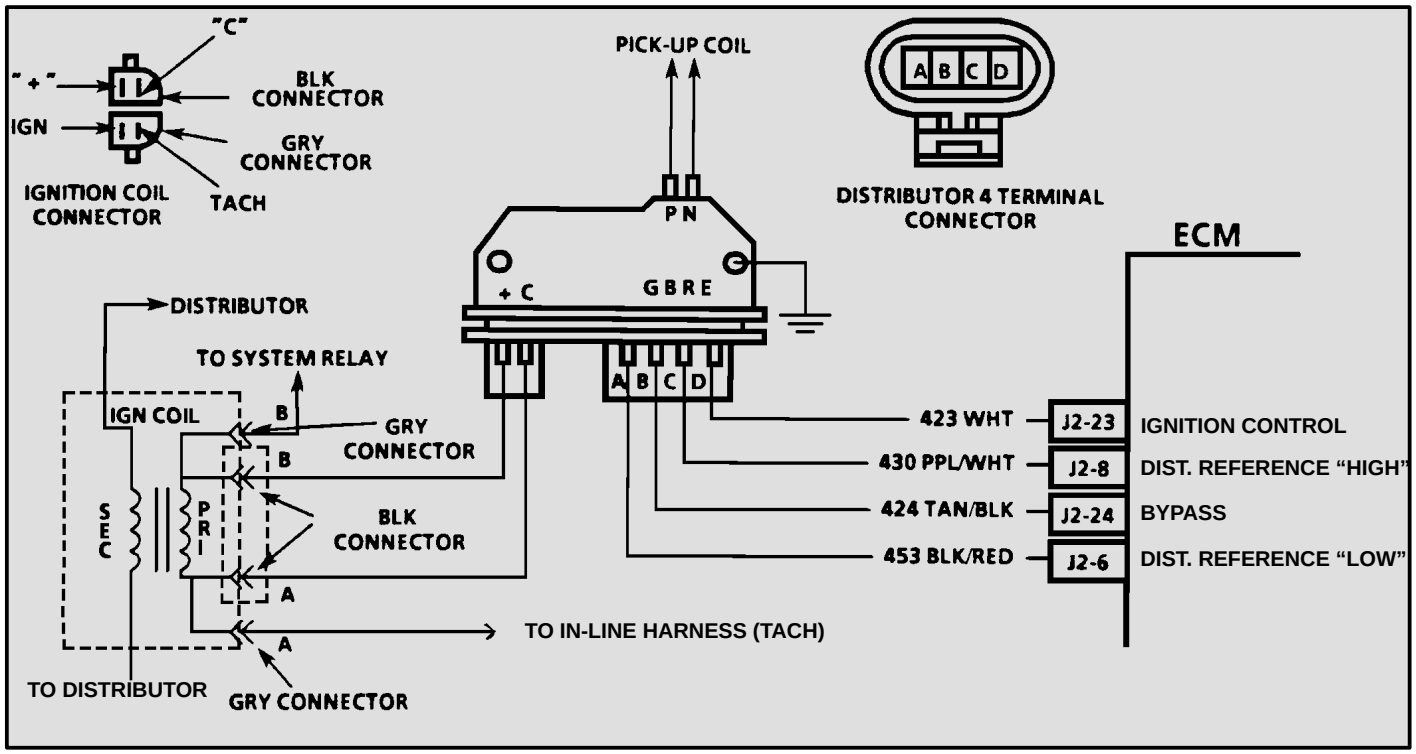
Index

Ignition System Check(1 of 2)


1
DISCONNECT TACH BEFORE PROCEEDING WITH THE TEST.
CHECK SPARK AT PLUG WIRE USING AN INDUCTIVE PICKUP TIMING LIGHT WHILE CRANKING. A FLASHING LIGHT INDICATES SPARK. (IF NO SPARK ON FIRST WIRE, CHECK SECOND WIRE.) A FEW SPARKS AND THEN NOTHING IS CONSIDERED NO SPARK.
NO SPARK
SPARK
1A
DISCONNECT 4 TERMINAL CONNECTOR ON DISTRIBUTOR AND CHECK FOR SPARK.
CHECK FUEL, SPARK PLUGS, ETC. SEE "TROUBLESHOOTING."
NO SPARK
SPARK
2
CHECK FOR SPARK AT COIL WIRE WITH TIMING LIGHT WHILE CRANKING. (LEAVE TIMING LIGHT CONNECTED TO COIL WIRE FOR STEPS 3-6).
REPLACE MAGNETIC SHAFT ASSEMBLY.
NO SPARK
SPARK
3
DISCONNECT DISTRIBUTOR 2 WIRE TERMINAL "C/+" PNK/BRN CONNECTOR. IGNITION SWITCH "ON," ENGINE STOPPED.
CHECK VOLTAGE AT "+ BRN" AND "C PNK" TERMINALS OF DISTRIBUTOR HARNESS CONNECTION.
INSPECT CAP FOR WATER, CRACKS, ETC. IF OK, REPLACE ROTOR.
4
BOTH TERMINALS 10 VOLTS OR MORE
BOTH TERMINALS UNDER 10 VOLTS
UNDER 10 VOLTS "C PNK"TERMINAL ONLY
RECONNECT DISTRIBUTOR 2 TERMINAL CONNECTOR.
WITH IGNITION "ON," CHECK VOLTAGE FROM TACH. TERMINAL TO GROUND
REPAIR WIRE FROM MODULE "+" TERMINAL TO "B" TERMINAL OF BLACK IGNITION COIL CONNECTOR OR PRIMARY CKT. TO IGNITION SWITCH.
CHECK FOR OPEN OR GROUND IN CKT. FROM "C" TERMINAL TO IGNITION COIL. IF CKT IS OK, FAULT IS IGNITION COIL OR CONNECTION.
OVER 10 VOLTS
UNDER 1 VOLT
1 TO 10 VOLTS
CONNECT TEST LIGHT FROM TACH. TERMINAL TO GROUND.
CRANK ENGINE AND OBSERVE LIGHT.
REPAIR OPEN TACH. LEAD OR CONNECTION AND REPEAT TEST #4.
REPLACE MODULE AND CHECK FOR SPARK FROM COIL AS IN STEP 6.
SPARK
NO SPARK
SYSTEM OK
REPLACE IGNITION COIL.
CHART CONTINUED ON PAGE 57
a
b

Index

Ignition System Check
(2 of 2)



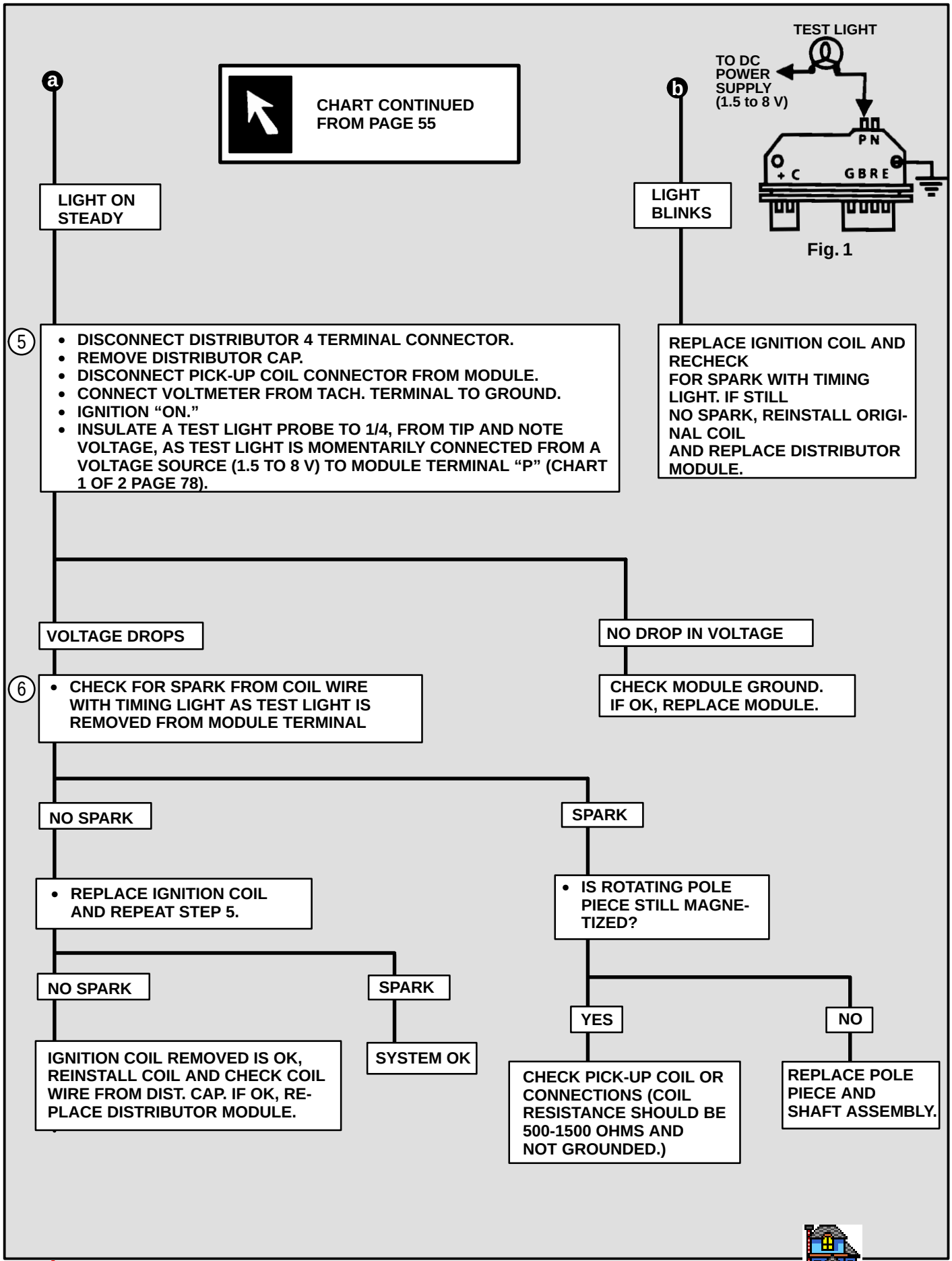
TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

5. Applying a voltage (1.5 to 8 volts) to module terminal "P" should turn the module ON and the "Tach" terminal voltage should drop to about 7-9 volts. This test will determine whether the module or coil is faulty or if the pick-up coil is not generating the proper signal to turn the module "ON." This test can be performed by using a DC battery with a rating of 1.5 to 8 volts. The use of the test light is mainly to allow the "P" terminal to be probed more easily. Some digital multimeter can also be used to trigger the module by selecting ohms, usually the diode position. In this position, the meter may have a voltage across its terminals which can be used to trigger the module. The voltage in the ohms position can be checked by using a second meter or by checking the manufacturer's specification of the tool being used.
6. This should turn OFF the module and cause a spark. If no spark occurs, the fault is most likely in the ignition coil because most module problems would have been found before this point in the procedure.

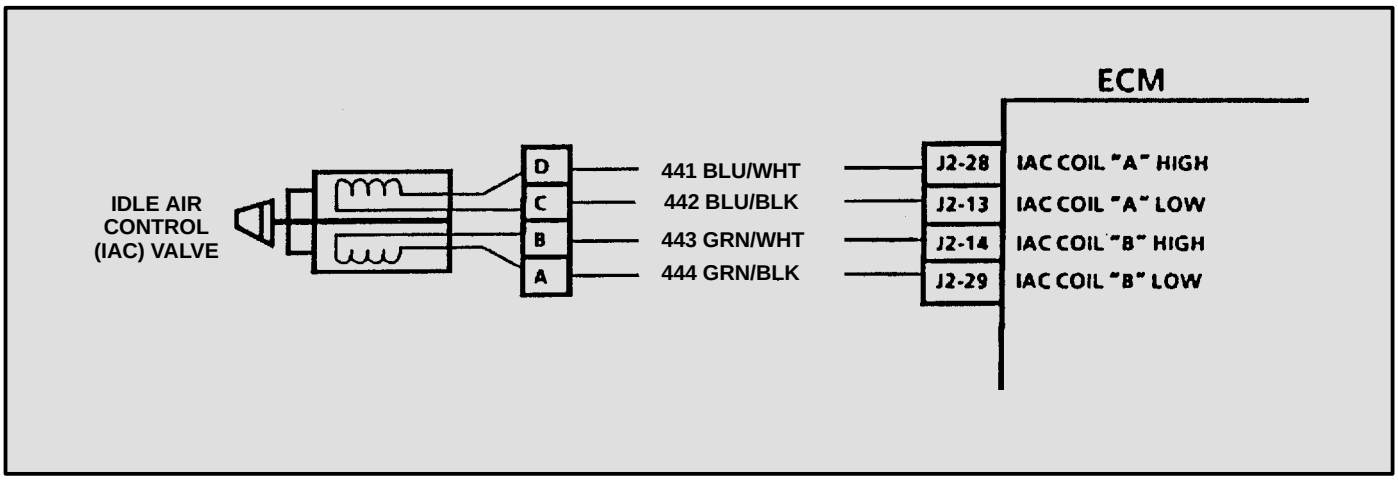
Index

Ignition System Check (2 of 2)


a
CHART CONTINUED FROM PAGE 55
b
TEST LIGHT
TO DC POWER SUPPLY (1.5 to 8 V)
P N
+ C
GBRE
Fig. 1
LIGHT ON STEADY
LIGHT BLINKS
5
• DISCONNECT DISTRIBUTOR 4 TERMINAL CONNECTOR.
• REMOVE DISTRIBUTOR CAP.
• DISCONNECT PICK-UP COIL CONNECTOR FROM MODULE.
• CONNECT VOLTMETER FROM TACH. TERMINAL TO GROUND.
• IGNITION "ON."
• INSULATE A TEST LIGHT PROBE TO 1/4, FROM TIP AND NOTE VOLTAGE, AS TEST LIGHT IS MOMENTARILY CONNECTED FROM A VOLTAGE SOURCE (1.5 TO 8 V) TO MODULE TERMINAL "P" (CHART 1 OF 2 PAGE 78).
REPLACE IGNITION COIL AND RECHECK FOR SPARK WITH TIMING LIGHT. IF STILL NO SPARK, REINSTALL ORIGINAL COIL AND REPLACE DISTRIBUTOR MODULE.
VOLTAGE DROPS
NO DROP IN VOLTAGE
6
• CHECK FOR SPARK FROM COIL WIRE WITH TIMING LIGHT AS TEST LIGHT IS REMOVED FROM MODULE TERMINAL
CHECK MODULE GROUND. IF OK, REPLACE MODULE.
NO SPARK
SPARK
• REPLACE IGNITION COIL AND REPEAT STEP 5.
• IS ROTATING POLE PIECE STILL MAGNETIZED?
NO SPARK
SPARK
YES
NO
IGNITION COIL REMOVED IS OK, REINSTALL COIL AND CHECK COIL WIRE FROM DIST. CAP. IF OK, REPLACE DISTRIBUTOR MODULE.
SYSTEM OK
CHECK PICK-UP COIL OR CONNECTIONS (COIL RESISTANCE SHOULD BE 500-1500 OHMS AND NOT GROUNDED.)
REPLACE POLE PIECE AND SHAFT ASSEMBLY.

Index

Idle Air Control (IAC) Functional Test (1 of 2)



CIRCUIT DESCRIPTION:

The ECM controls idle speed to a calculated, "desired" RPM based on sensor inputs and actual engine RPM, determined by the time between successive ignition reference pulses from the ignition module. The ECM uses four circuits to move an Idle Air Control (IAC) valve, which allows varying amounts of air flow into the intake manifold, controlling idle speed.

IMPORTANT: Improper IAC readings or improper idle speed can result from other faults ie: flooding VST, fouled spark plugs, bad sensors. These items should be in proper working order to ensure correct diagnosis.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the functional check chart.

1. This step determines if the IAC valve is functioning properly.
2. This step determines if the circuitry or the IAC valve is faulty.

DIAGNOSTIC AIDS:

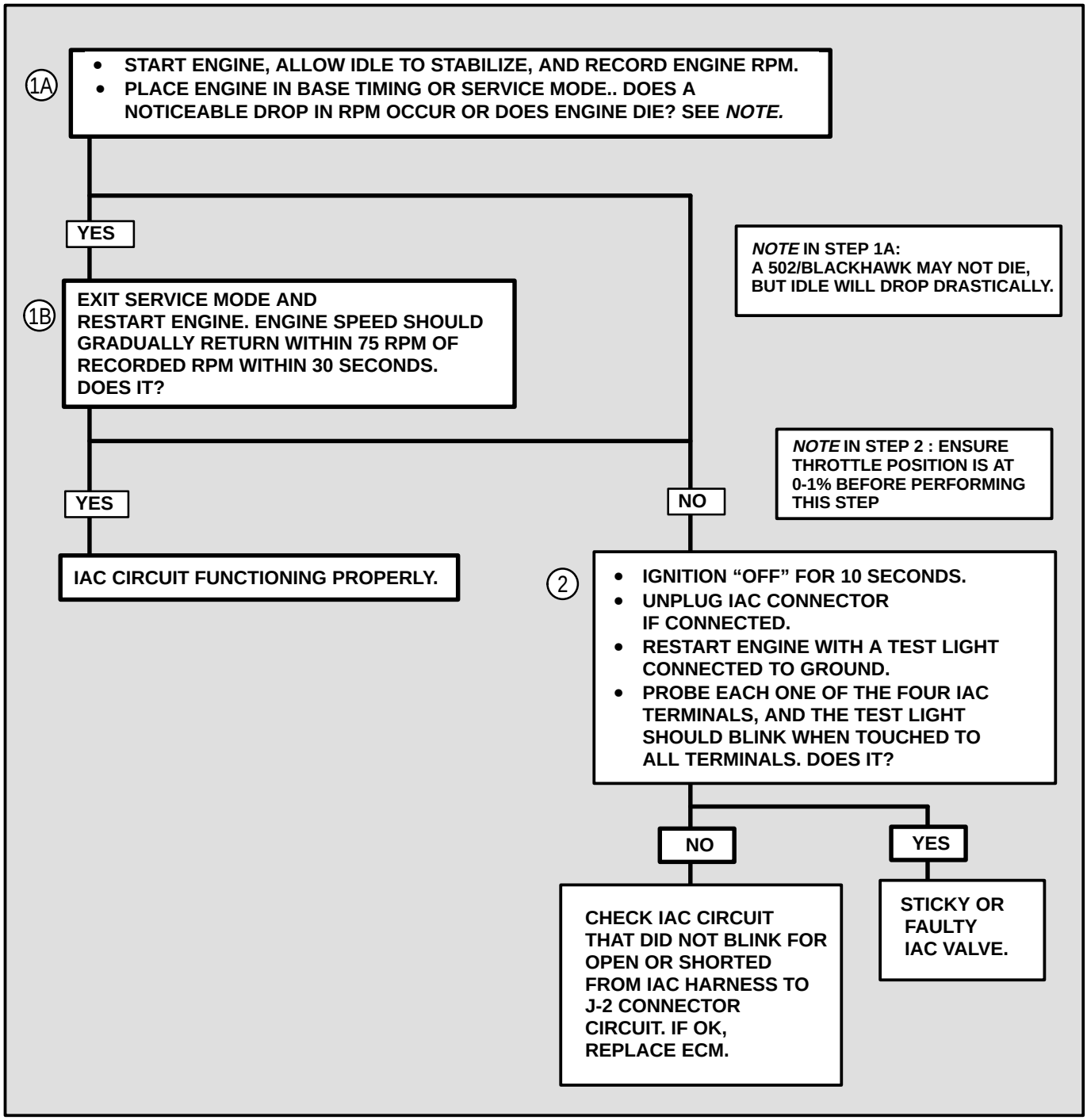
Check for vacuum leaks, unconnected or brittle vacuum hoses, cuts, etc. Examine manifold and throttle body gaskets for proper seal. Check for cracked intake manifold/plenum. Check open, shorts, or poor connections to IAC valve in CKTs 441, 442, 443 and 444.

An open, short, or poor connection in CKTs 441, 442, 443, or 444 will result in improper idle control and may cause improper idle.

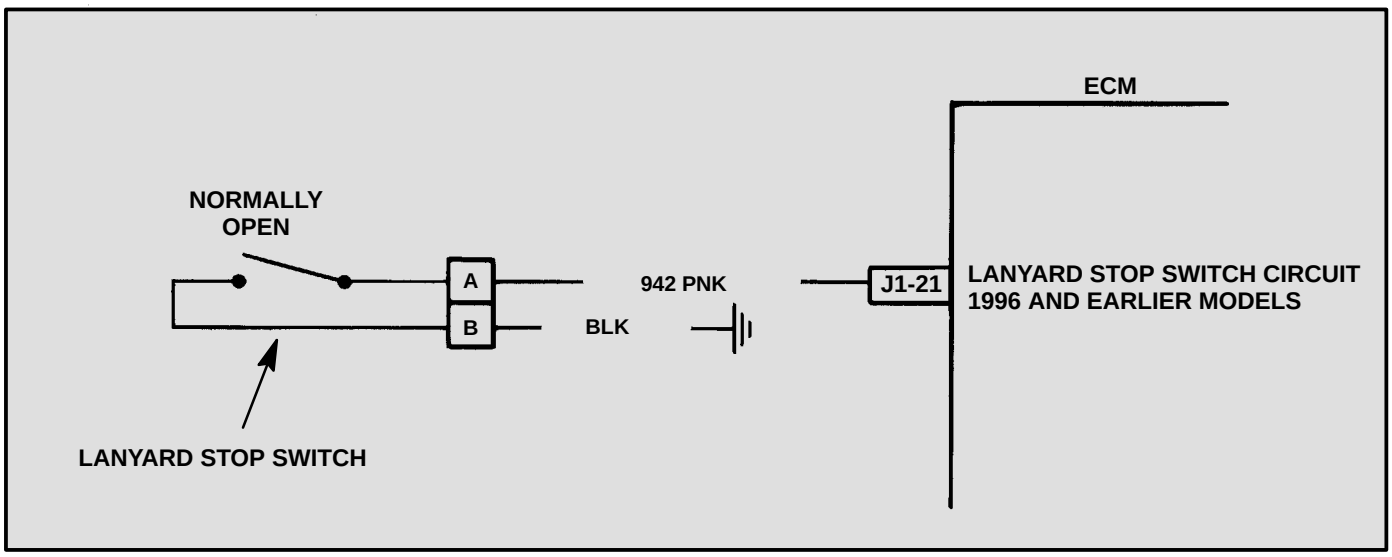
An IAC valve which is stopped and cannot respond to the ECM, a throttle stop screw which has been tampered with, or a damaged throttle body or linkage could cause improper idle.

Index

Idle Air Control Functional Test
(2 of 2)


1A
START ENGINE, ALLOW IDLE TO STABILIZE, AND RECORD ENGINE RPM.
PLACE ENGINE IN BASE TIMING OR SERVICE MODE.. DOES A NOTICEABLE DROP IN RPM OCCUR OR DOES ENGINE DIE? SEE NOTE.
YES
NOTE IN STEP 1A:
A 502/BLACKHAWK MAY NOT DIE, BUT IDLE WILL DROP DRASTICALLY.
1B
EXIT SERVICE MODE AND RESTART ENGINE. ENGINE SPEED SHOULD GRADUALLY RETURN WITHIN 75 RPM OF RECORDED RPM WITHIN 30 SECONDS. DOES IT?
YES
NO
NOTE IN STEP 2 : ENSURE THROTTLE POSITION IS AT 0-1% BEFORE PERFORMING THIS STEP
IAC CIRCUIT FUNCTIONING PROPERLY.
2
IGNITION "OFF" FOR 10 SECONDS.
UNPLUG IAC CONNECTOR IF CONNECTED.
RESTART ENGINE WITH A TEST LIGHT CONNECTED TO GROUND.
PROBE EACH ONE OF THE FOUR IAC TERMINALS, AND THE TEST LIGHT SHOULD BLINK WHEN TOUCHED TO ALL TERMINALS. DOES IT?
NO
YES
CHECK IAC CIRCUIT THAT DID NOT BLINK FOR OPEN OR SHORTED FROM IAC HARNESS TO J-2 CONNECTOR CIRCUIT. IF OK, REPLACE ECM.
STICKY OR FAULTY IAC VALVE.

Lanyard Stop Circuit Check (Emergency Stop) Circuit Check (1 of 2)



NOTE: *Some models are no longer equipped with this option in the wiring harness. Connection of the lanyard stop switch (if equipped) is performed at the instrument panel.*

CIRCUIT DESCRIPTION:

The Lanyard Stop circuit is a safety feature incorporated in boats to stop the engine in the event that the operator is removed from a safe control position during normal operation. The Lanyard Stop switch is a normally open switch that is physically connected to the operator by a tether. In the event that the operator is removed from a control position, the tether connected to the switch will be pulled out, closing the switch. This information from the Lanyard Stop switch will then be used by the ECM to cease engine operation until the position of the switch is restored to its normally open position and the ignition key switch has been cycled.

TEST DESCRIPTION:

1. If a Lanyard Stop was recognized by the ECM, cycling the ignition will clear the Lanyard Stop condition in the ECM.
2. This step checks to see if the Lanyard Stop switch is in the correct position. If the switch is closed, a Lanyard Stop condition will exist.
3. This step checks for Lanyard Stop switch or Lanyard Stop circuitry that is shorted to ground.
4. This step identifies which half of the circuitry is shorted to ground; i.e., ECM side or switch side.
5. This step identifies if the circuitry or ECM is the cause of the short to ground.

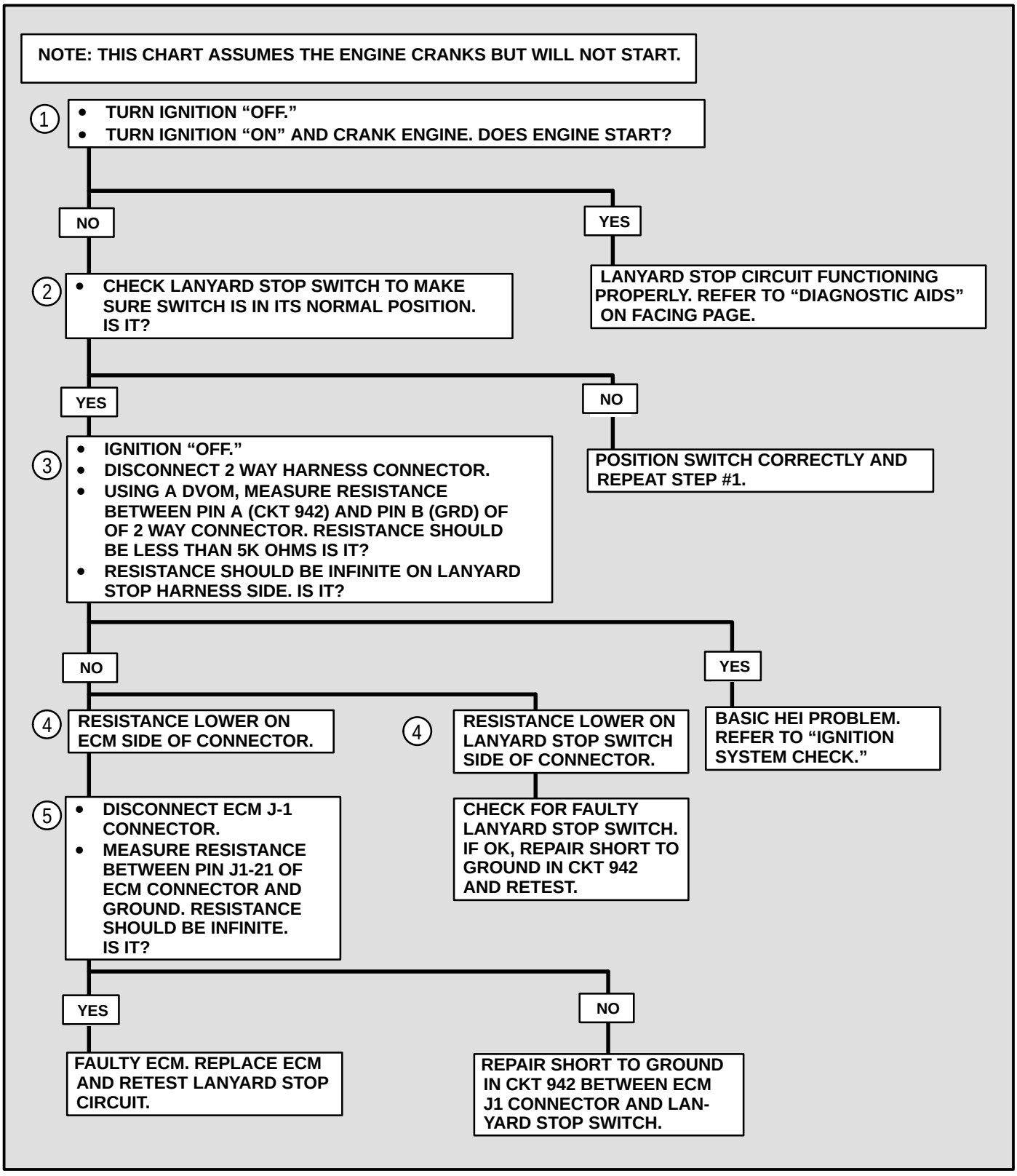
DIAGNOSTIC AIDS:

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness.

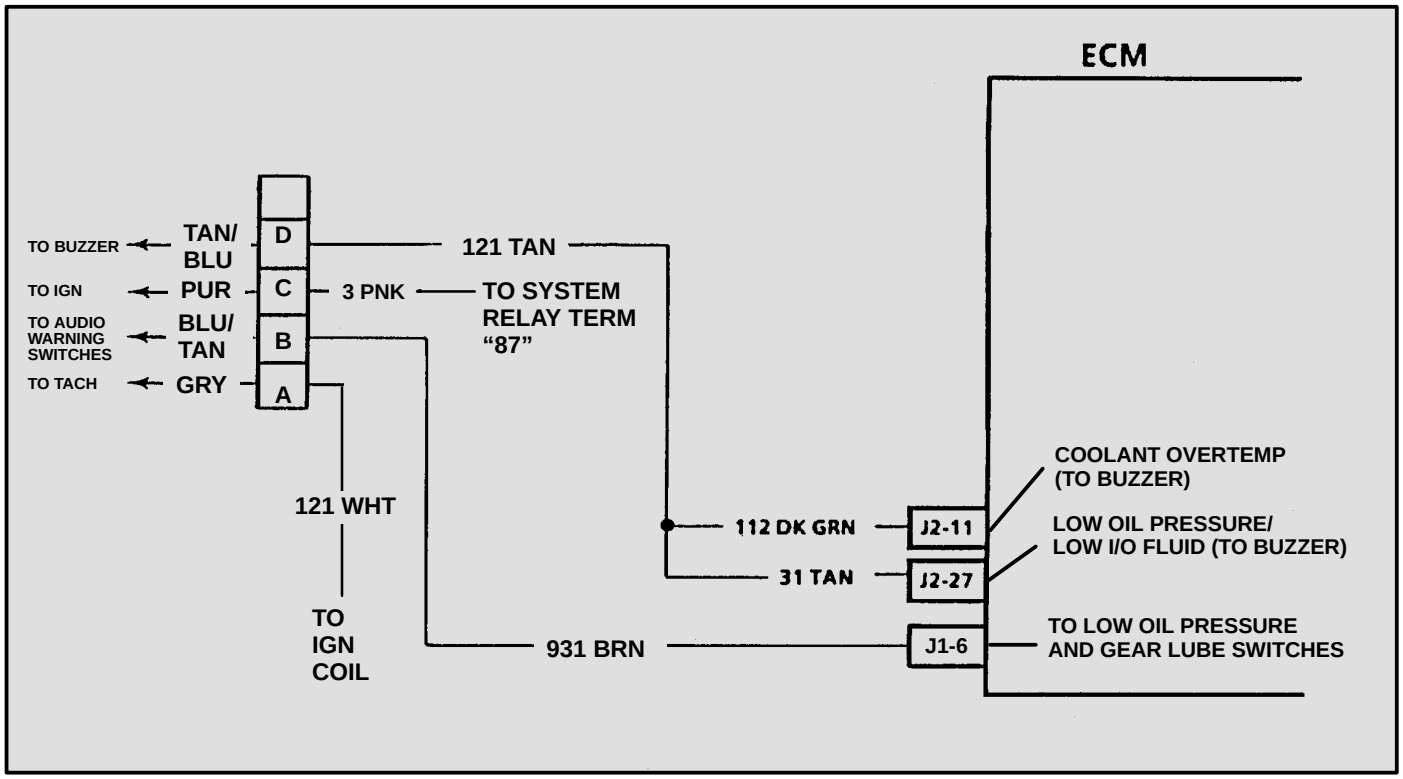
Index

Lanyard Stop (Emergency Stop) Circuit Check (2 of 2)


NOTE: THIS CHART ASSUMES THE ENGINE CRANKS BUT WILL NOT START.
1
• TURN IGNITION "OFF."
• TURN IGNITION "ON" AND CRANK ENGINE. DOES ENGINE START?
NO
YES
LANYARD STOP CIRCUIT FUNCTIONING PROPERLY. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
2
• CHECK LANYARD STOP SWITCH TO MAKE SURE SWITCH IS IN ITS NORMAL POSITION. IS IT?
YES
NO
POSITION SWITCH CORRECTLY AND REPEAT STEP #1.
3
• IGNITION "OFF."
• DISCONNECT 2 WAY HARNESS CONNECTOR.
• USING A DVOM, MEASURE RESISTANCE BETWEEN PIN A (CKT 942) AND PIN B (GRD) OF OF 2 WAY CONNECTOR. RESISTANCE SHOULD BE LESS THAN 5K OHMS IS IT?
• RESISTANCE SHOULD BE INFINITE ON LANYARD STOP HARNESS SIDE. IS IT?
NO
YES
BASIC HEI PROBLEM. REFER TO "IGNITION SYSTEM CHECK."
4
RESISTANCE LOWER ON ECM SIDE OF CONNECTOR.
4
RESISTANCE LOWER ON LANYARD STOP SWITCH SIDE OF CONNECTOR.
CHECK FOR FAULTY LANYARD STOP SWITCH. IF OK, REPAIR SHORT TO GROUND IN CKT 942 AND RETEST.
5
• DISCONNECT ECM J-1 CONNECTOR.
• MEASURE RESISTANCE BETWEEN PIN J1-21 OF ECM CONNECTOR AND GROUND. RESISTANCE SHOULD BE INFINITE. IS IT?
YES
NO
FAULTY ECM. REPLACE ECM AND RETEST LANYARD STOP CIRCUIT.
REPAIR SHORT TO GROUND IN CKT 942 BETWEEN ECM J1 CONNECTOR AND LANYARD STOP SWITCH.

Index

Audio Warning Buzzer Circuit Check (1 of 2)



CIRCUIT DESCRIPTION:

The audio warning buzzer function of the ECM is used to alert the operator of a critical engine function parameter. Used in conjunction with the discrete input circuitry, the ECM will supply ignition current to activate the buzzer if a change of state is indicated by any of the discrete inputs. When a discrete switch changes state from normally open to closed, the ECM interprets that an anomaly is present and will complete the ground to the affected buzzer circuit, energizing the buzzer.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the functional check chart.

1. This step performs a functional check of the buzzer circuit.
2. This step identifies a short to ground in the control circuit.
3. This step identifies an open in the control circuit.
4. This step identifies if the fault is a short in the harness or a faulty ECM.
5. This step checks for an open in the circuitry from the harness connector to the ignition fuse.
6. This step identifies if the open circuit is due to a faulty ECM or warning buzzer circuitry.

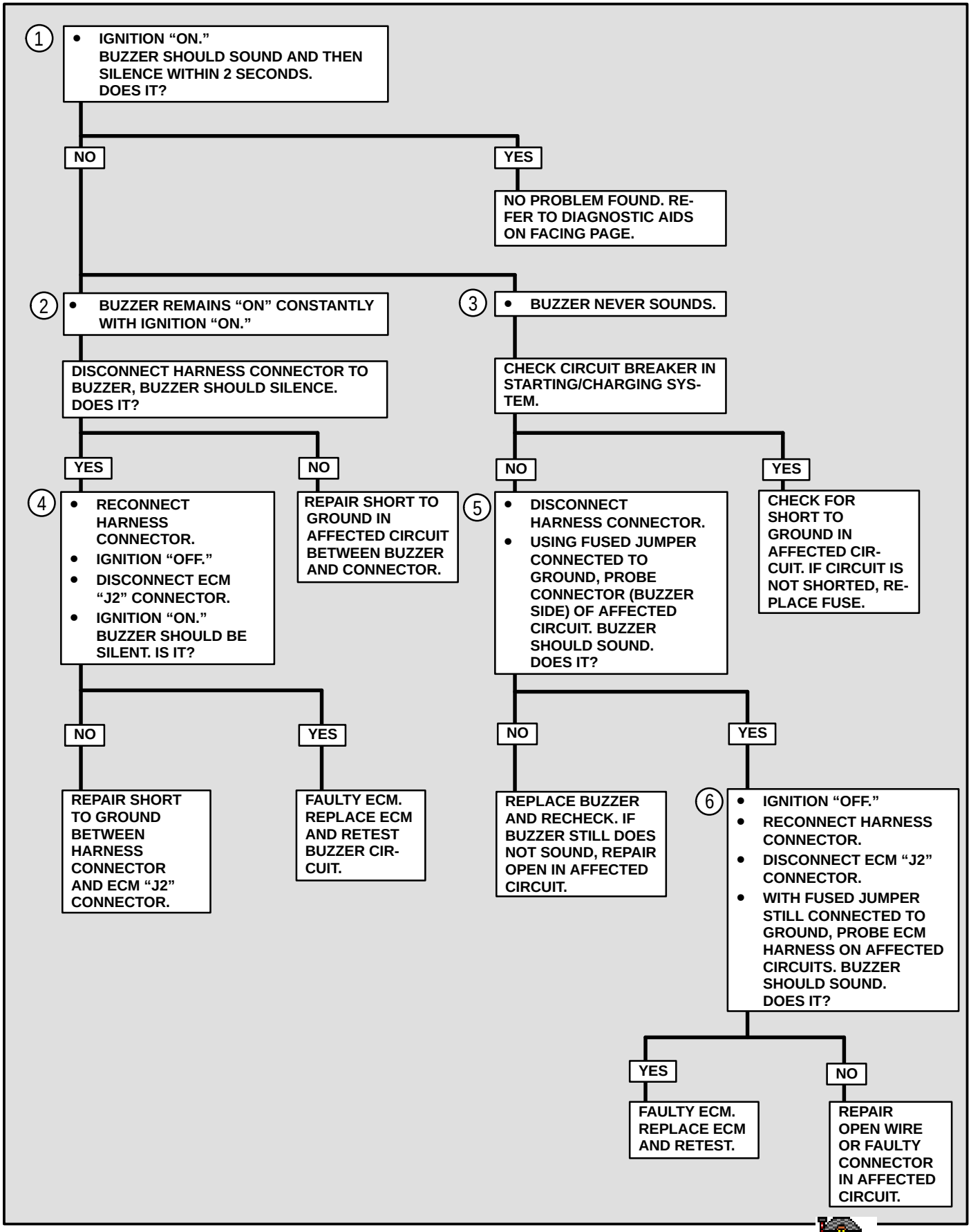
DIAGNOSTIC AIDS:

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness.

Index

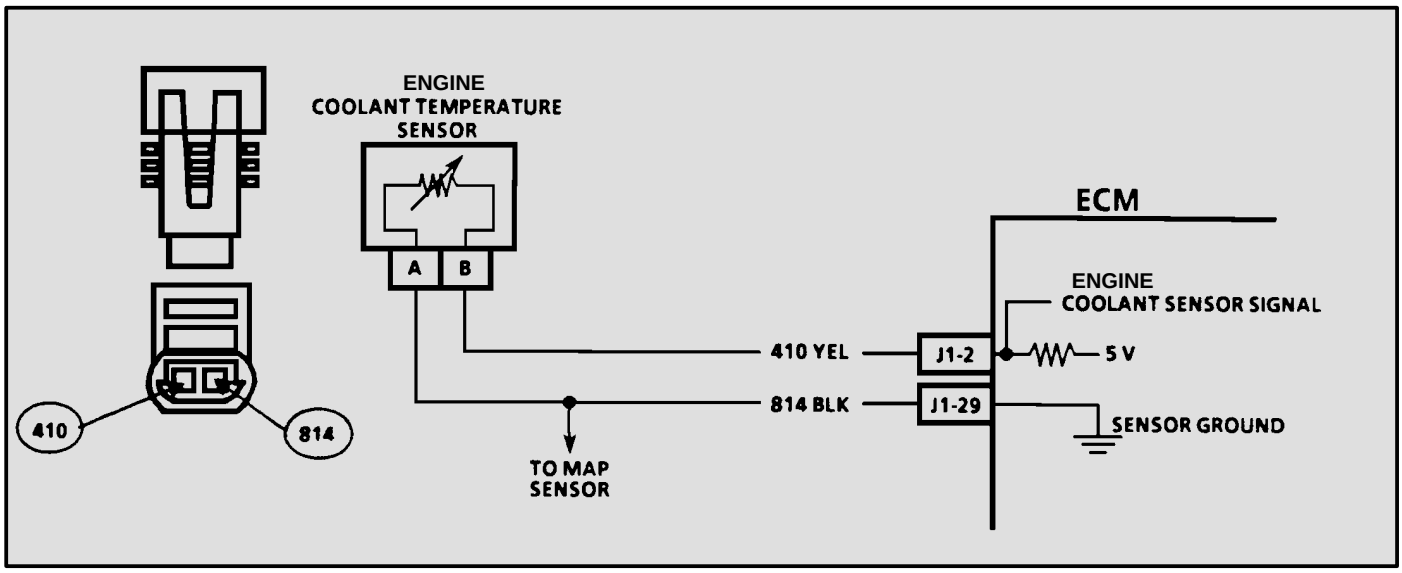
Audio Warning Buzzer Circuit Check (2 of 2)


1
IGNITION "ON." BUZZER SHOULD SOUND AND THEN SILENCE WITHIN 2 SECONDS. DOES IT?
NO
YES
NO PROBLEM FOUND. REFER TO DIAGNOSTIC AIDS ON FACING PAGE.
2
BUZZER REMAINS "ON" CONSTANTLY WITH IGNITION "ON."
3
BUZZER NEVER SOUNDS.
DISCONNECT HARNESS CONNECTOR TO BUZZER, BUZZER SHOULD SILENCE. DOES IT?
CHECK CIRCUIT BREAKER IN STARTING/CHARGING SYSTEM.
YES
NO
NO
YES
4
RECONNECT HARNESS CONNECTOR.
IGNITION "OFF."
DISCONNECT ECM "J2" CONNECTOR.
IGNITION "ON." BUZZER SHOULD BE SILENT. IS IT?
REPAIR SHORT TO GROUND IN AFFECTED CIRCUIT BETWEEN BUZZER AND CONNECTOR.
5
DISCONNECT HARNESS CONNECTOR.
USING FUSED JUMPER CONNECTED TO GROUND, PROBE CONNECTOR (BUZZER SIDE) OF AFFECTED CIRCUIT. BUZZER SHOULD SOUND. DOES IT?
CHECK FOR SHORT TO GROUND IN AFFECTED CIRCUIT. IF CIRCUIT IS NOT SHORTED, REPLACE FUSE.
NO
YES
NO
YES
REPAIR SHORT TO GROUND BETWEEN HARNESS CONNECTOR AND ECM "J2" CONNECTOR.
FAULTY ECM. REPLACE ECM AND RETEST BUZZER CIRCUIT.
REPLACE BUZZER AND RECHECK. IF BUZZER STILL DOES NOT SOUND, REPAIR OPEN IN AFFECTED CIRCUIT.
6
IGNITION "OFF."
RECONNECT HARNESS CONNECTOR.
DISCONNECT ECM "J2" CONNECTOR.
WITH FUSED JUMPER STILL CONNECTED TO GROUND, PROBE ECM HARNESS ON AFFECTED CIRCUITS. BUZZER SHOULD SOUND. DOES IT?
YES
NO
FAULTY ECM. REPLACE ECM AND RETEST.
REPAIR OPEN WIRE OR FAULTY CONNECTOR IN AFFECTED CIRCUIT.

Index

Diagnostics-Without Scan Tool

Code 14: Engine Coolant Temperature (ECT) Sensor Circuit (Non-Scan) (1 of 2)



CIRCUIT DESCRIPTION:

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high; therefore, the ECM will see high signal voltage.

As the engine coolant warms, the sensor resistance becomes less, and the voltage drops.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step checks if there is a problem with the ECM and wiring or if the problem is the coolant sensor.
2. Check the harness terminals thoroughly for loose connection. If the resistance or the coolant sensor is monitored, the resistance should steadily decrease as the engine coolant warms up. The resistance reading would stabilize when the thermostat opens.
3. This step will isolate the problem to CKT 410 (5 volt reference) or to the sensor ground.
4. This step identifies if CKT 410 is open or shorted to ground.

DIAGNOSTIC AIDS:

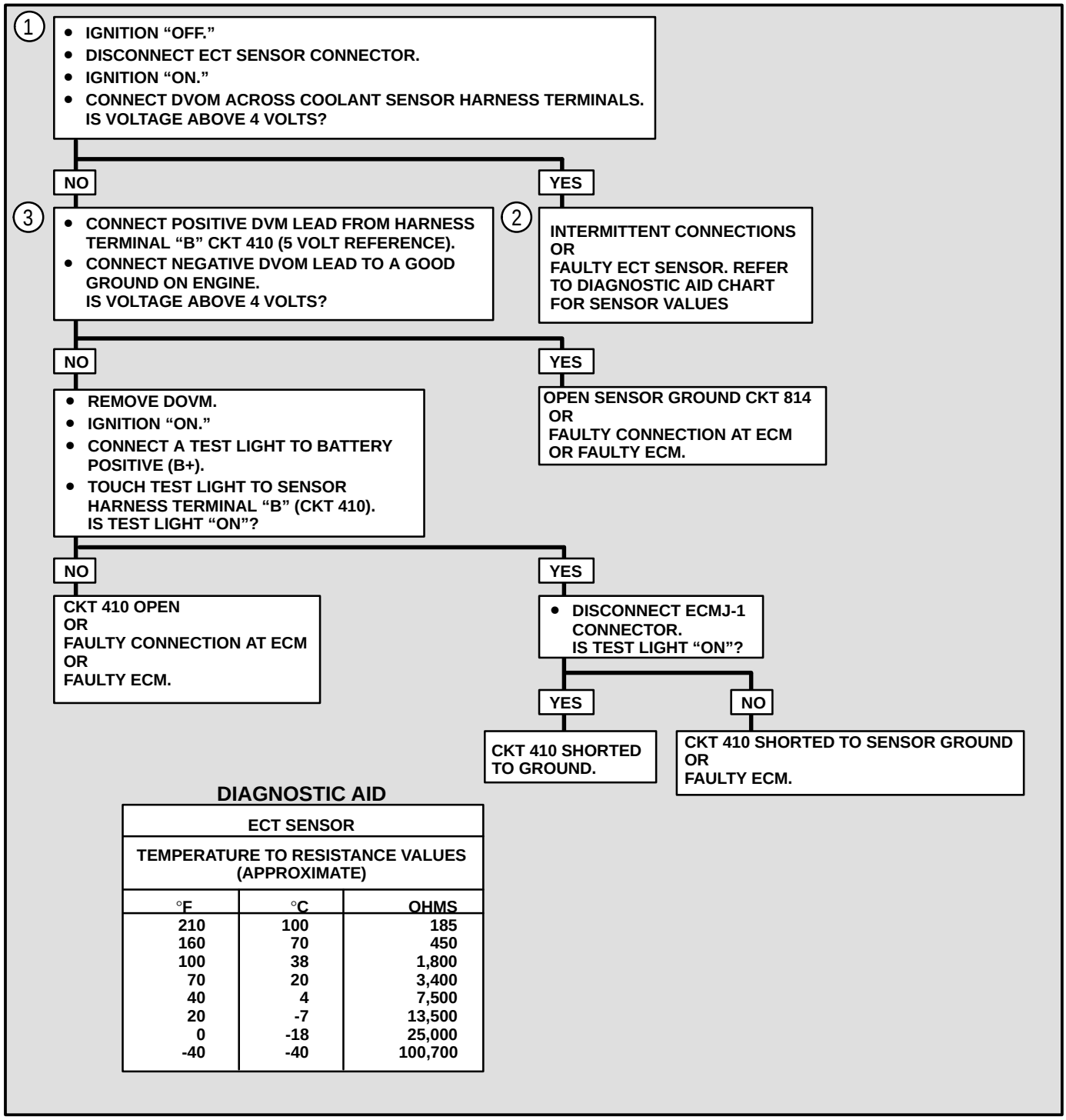
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared. Check harness routing for a potential short to ground in CKT 410. See “Intermittents” in “Troubleshooting.”

IMPORTANT: If replacing the ECT, tighten hand tight plus 2-1/2 turns maximum.

Index

Code 14: ECT Circuit (Non-Scan)
(2 of 2)


1
IGNITION "OFF."
DISCONNECT ECT SENSOR CONNECTOR.
IGNITION "ON."
CONNECT DVOM ACROSS COOLANT SENSOR HARNESS TERMINALS.
IS VOLTAGE ABOVE 4 VOLTS?
NO
YES
3
CONNECT POSITIVE DVM LEAD FROM HARNESS TERMINAL "B" CKT 410 (5 VOLT REFERENCE).
CONNECT NEGATIVE DVOM LEAD TO A GOOD GROUND ON ENGINE.
IS VOLTAGE ABOVE 4 VOLTS?
2
INTERMITTENT CONNECTIONS OR FAULTY ECT SENSOR. REFER TO DIAGNOSTIC AID CHART FOR SENSOR VALUES
NO
YES
REMOVE DOVM.
IGNITION "ON."
CONNECT A TEST LIGHT TO BATTERY POSITIVE (B+).
TOUCH TEST LIGHT TO SENSOR HARNESS TERMINAL "B" (CKT 410).
IS TEST LIGHT "ON"?
OPEN SENSOR GROUND CKT 814 OR FAULTY CONNECTION AT ECM OR FAULTY ECM.
NO
YES
CKT 410 OPEN OR FAULTY CONNECTION AT ECM OR FAULTY ECM.
DISCONNECT ECMJ-1 CONNECTOR.
IS TEST LIGHT "ON"?
YES
NO
CKT 410 SHORTED TO GROUND.
CKT 410 SHORTED TO SENSOR GROUND OR FAULTY ECM.

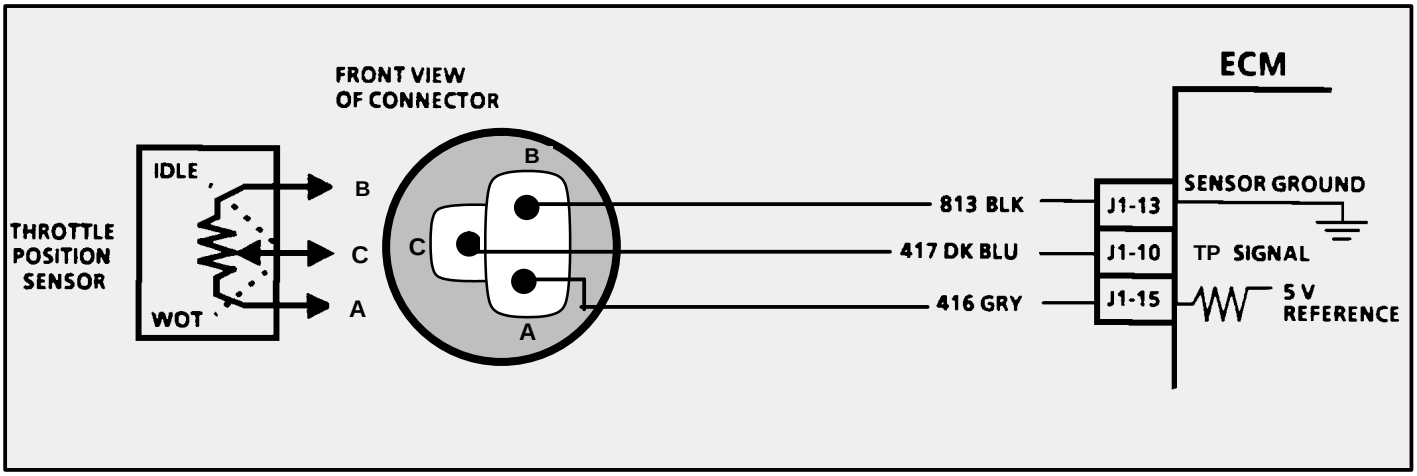
DIAGNOSTIC AID

ECT SENSOR

TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)

°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

Code 21: Throttle Position (TP) Sensor Circuit (Non-Scan) (1 Of 2)



CIRCUIT DESCRIPTION:

The Throttle Position (TP) sensor provides a voltage signal that changes, relative to the throttle blade. Signal voltage should vary from about .7 volts at idle to about 4.5 volts at Wide Open Throttle (W.O.T.).

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step checks for a voltage from terminal “C” (5 volt reference) to terminal “A” (sensor ground).
2. This step will identify if the problem is in the supply or ground circuit.
3. This step determines if the TP sensor signal circuit to the ECM is open.
4. This step completes the test for the ECM and wiring. If the test light is not ON, the TP sensor has an internal problem.

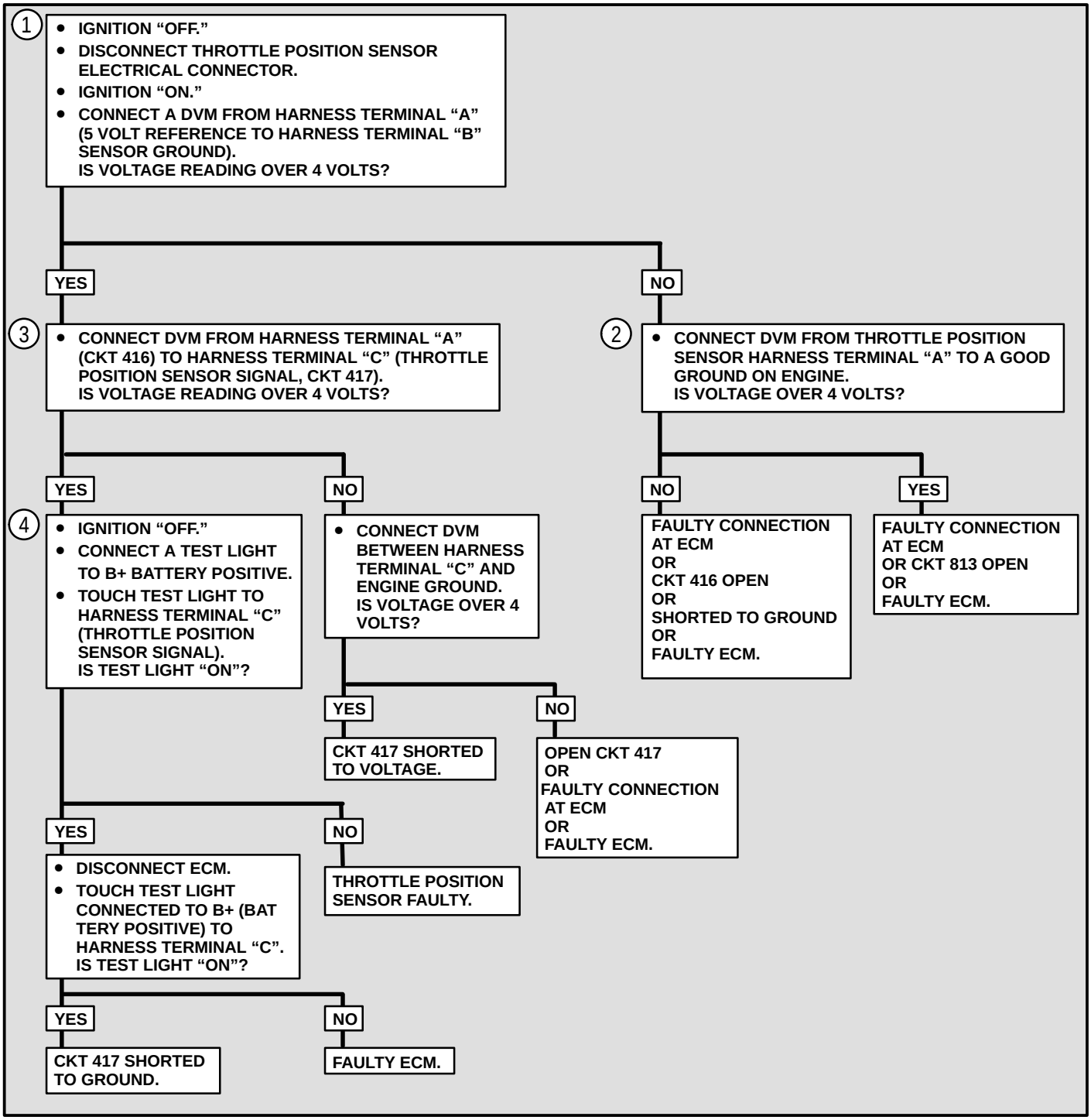
DIAGNOSTIC AIDS:

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

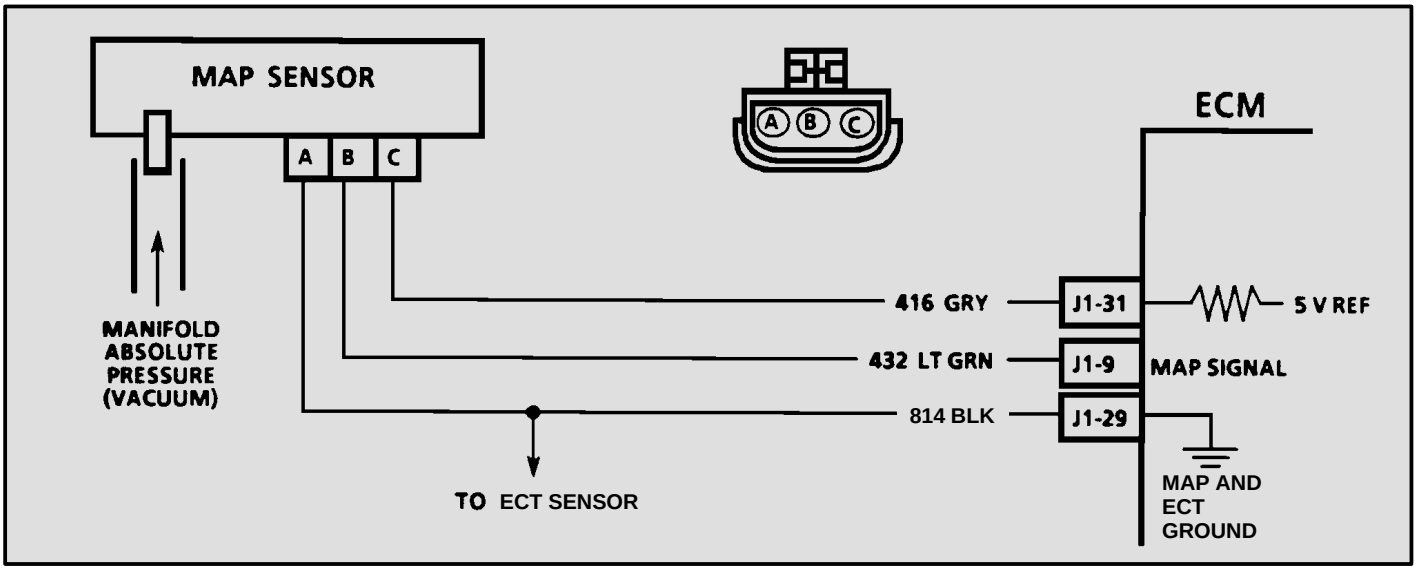
Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared. If Code 23 is also set, check CKT 813 for faulty wiring or connections. Check terminals at sensor for good contact.

Index

Code 21: Throttle Position (TP) Sensor Circuit (Non Scan)



Code 33: Manifold Absolute Pressure (MAP) Sensor Circuit (Non-Scan) (1 Of 2)



CIRCUIT DESCRIPTION:

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1-1.5 volts at closed throttle idle, to 4-4.8 volts at Wide Open Throttle (W.O.T.) (low vacuum).

If the MAP sensor fails, the ECM will substitute a fixed MAP value and use the engine RPM to control fuel delivery.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step will determine if there is an adequate vacuum supply to the MAP sensor. If the gauge reading is erratic, refer to “Stalling, Rough, Unstable or Incorrect Idle” in “Troubleshooting.”
2. Low manifold vacuum may result from vacuum leaks in the engine induction system.
3. This step checks for a voltage from terminal “C” (5 volt reference) to terminal “A” (sensor ground).
4. This step will identify if the problem is in the supply 5 V reference or ground circuit.
5. This step determines if the MAP signal circuit to the ECM is open.
6. This step completes the test for the ECM and wiring. If the test light is not ON, the MAP sensor has an internal problem. To confirm an internal MAP sensor problem, use the MAP output voltage check chart.

DIAGNOSTIC AIDS:

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared. If Code 14 is also set, check for open ground CKT 814.

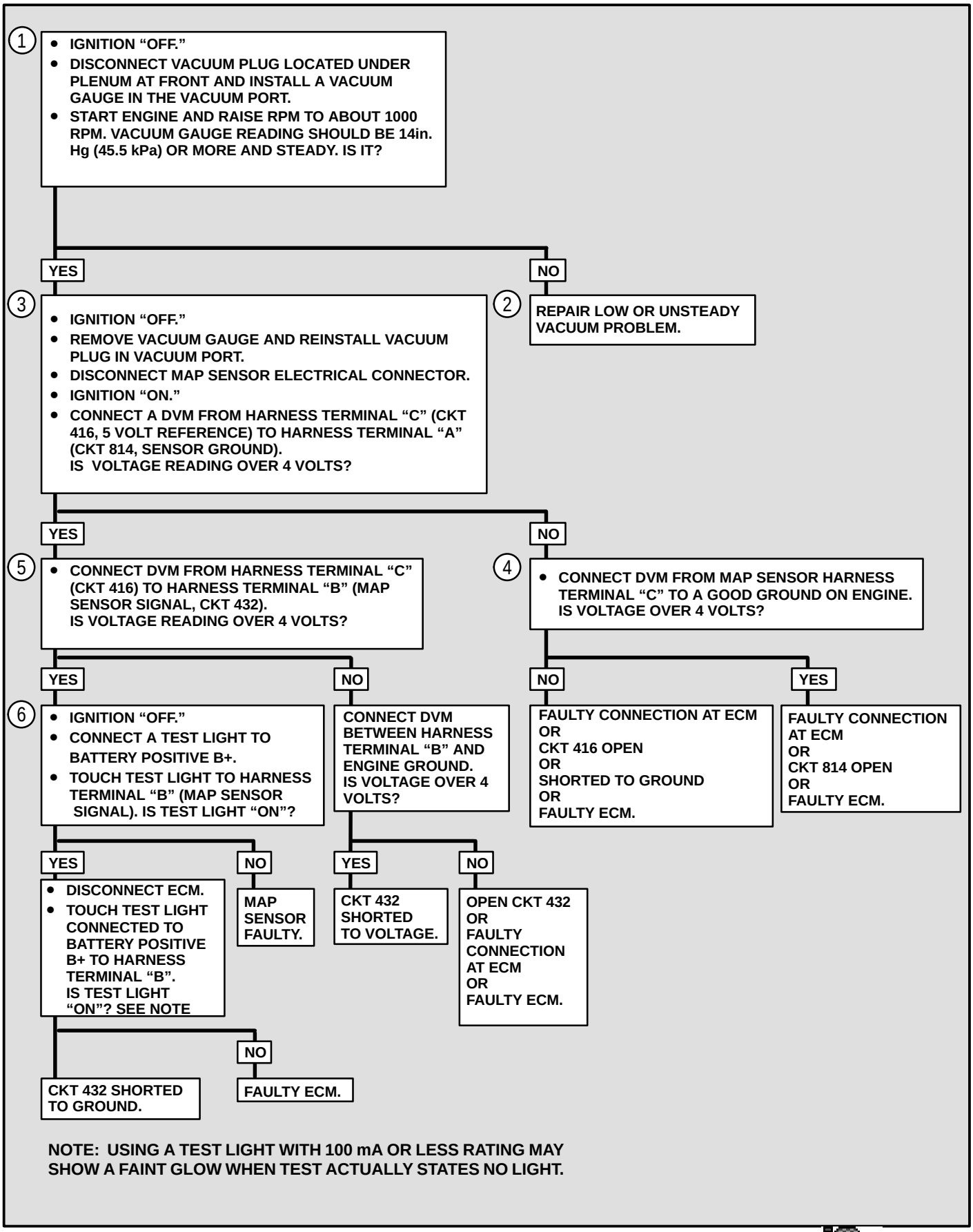
MAP SENSOR

ALTITUDE		VOLTAGE RANGE
Feet	Meters	
Below 1,000	Below 305	3.8-5.5 V
1,000-2,000	305-610	3.6-5.3 V
2,000-3,000	610-914	3.5-5.1 V
3,000-4,000	914-1219	3.3-5.0 V
4,000-5,000	1219-1524	3.2-4.8 V
5,000-6,000	1524-1829	3.0-4.6 V
6,000-7,000	1829-2133	2.9-4.5 V
7,000-8,000	2133-2438	2.8-4.3 V
8,000-9,000	2438-2743	2.6-4.2 V
9,000-10,000	2743-3048	2.5-4.0 V

LOW ALTITUDE = HIGH PRESSURE = HIGH VOLTAGE

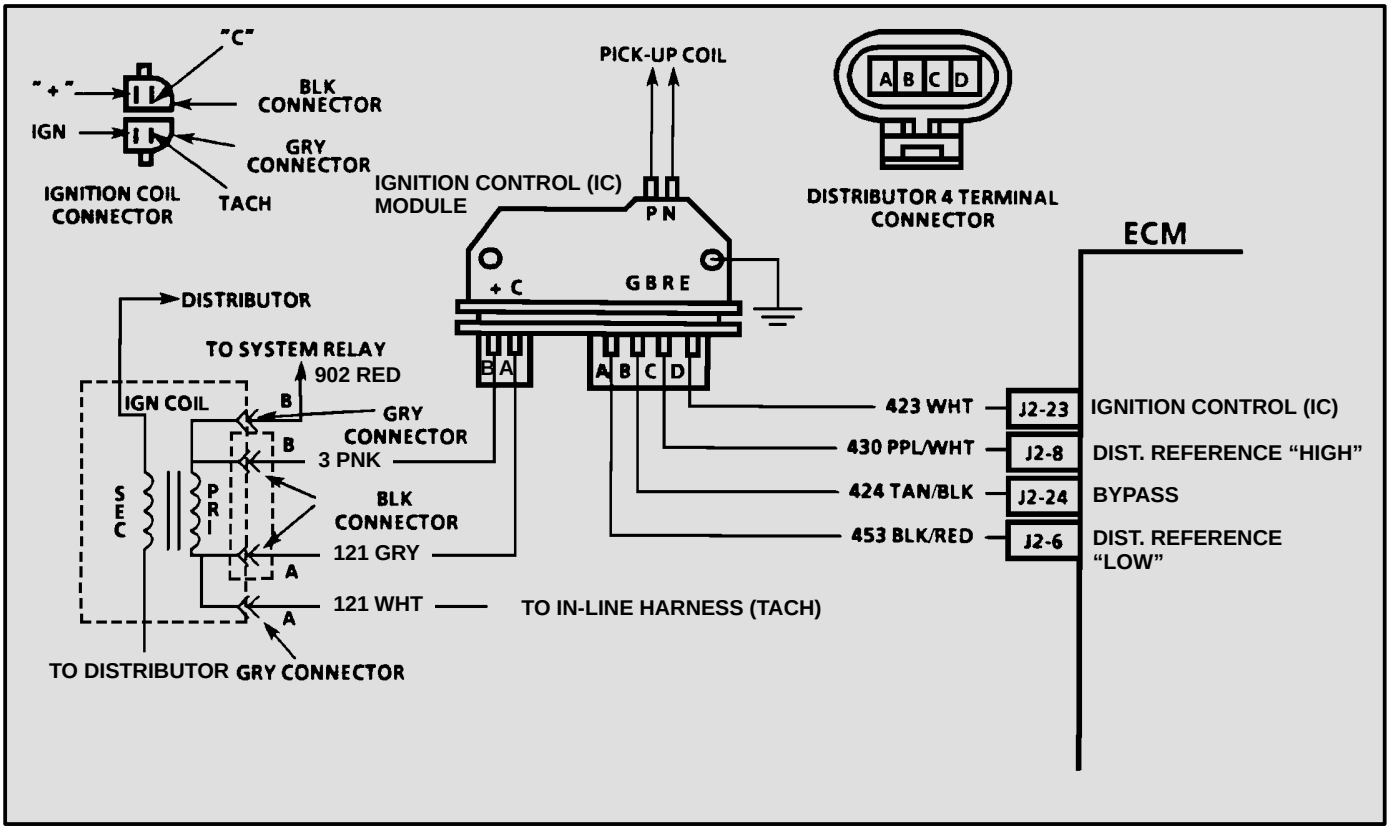
Index

Code 33: MAP Circuit (Non-Scan)
(2 of 2)


1
IGNITION "OFF."
DISCONNECT VACUUM PLUG LOCATED UNDER PLENUM AT FRONT AND INSTALL A VACUUM GAUGE IN THE VACUUM PORT.
START ENGINE AND RAISE RPM TO ABOUT 1000 RPM. VACUUM GAUGE READING SHOULD BE 14in. Hg (45.5 kPa) OR MORE AND STEADY. IS IT?
YES
NO
2
REPAIR LOW OR UNSTEADY VACUUM PROBLEM.
3
IGNITION "OFF."
REMOVE VACUUM GAUGE AND REINSTALL VACUUM PLUG IN VACUUM PORT.
DISCONNECT MAP SENSOR ELECTRICAL CONNECTOR.
IGNITION "ON."
CONNECT A DVM FROM HARNESS TERMINAL "C" (CKT 416, 5 VOLT REFERENCE) TO HARNESS TERMINAL "A" (CKT 814, SENSOR GROUND).
IS VOLTAGE READING OVER 4 VOLTS?
YES
NO
4
CONNECT DVM FROM MAP SENSOR HARNESS TERMINAL "C" TO A GOOD GROUND ON ENGINE.
IS VOLTAGE OVER 4 VOLTS?
5
CONNECT DVM FROM HARNESS TERMINAL "C" (CKT 416) TO HARNESS TERMINAL "B" (MAP SENSOR SIGNAL, CKT 432).
IS VOLTAGE READING OVER 4 VOLTS?
YES
NO
NO
YES
6
IGNITION "OFF."
CONNECT A TEST LIGHT TO BATTERY POSITIVE B+.
TOUCH TEST LIGHT TO HARNESS TERMINAL "B" (MAP SENSOR SIGNAL). IS TEST LIGHT "ON"?
CONNECT DVM BETWEEN HARNESS TERMINAL "B" AND ENGINE GROUND.
IS VOLTAGE OVER 4 VOLTS?
FAULTY CONNECTION AT ECM
OR
CKT 416 OPEN
OR
SHORTED TO GROUND
OR
FAULTY ECM.
FAULTY CONNECTION AT ECM
OR
CKT 814 OPEN
OR
FAULTY ECM.
YES
NO
YES
NO
DISCONNECT ECM.
TOUCH TEST LIGHT CONNECTED TO BATTERY POSITIVE B+ TO HARNESS TERMINAL "B".
IS TEST LIGHT "ON"? SEE NOTE
MAP SENSOR FAULTY.
CKT 432 SHORTED TO VOLTAGE.
OPEN CKT 432
OR
FAULTY CONNECTION AT ECM
OR
FAULTY ECM.
NO
CKT 432 SHORTED TO GROUND.
FAULTY ECM.
NOTE: USING A TEST LIGHT WITH 100 mA OR LESS RATING MAY SHOW A FAINT GLOW WHEN TEST ACTUALLY STATES NO LIGHT.

Index

Code 42: Ignition Control (IC) Circuit (Non-Scan) (1 of 2)



CIRCUIT DESCRIPTION:

When the system is running on the ignition module, that is, no voltage on the bypass line, the ignition module grounds the IC signal. The ECM expects to detect no voltage on the IC line during this condition. If it detects a voltage, it sets Code 42 and will not go into the IC mode.

When the RPM for IC is reached (about 300 RPM), and bypass voltage applied, the IC should no longer be grounded in the ignition module, so the IC voltage should be varying.

If the bypass line is open or grounded, the ignition module will not switch to IC mode so the IC voltage will be low and Code 42 will be set.

If the IC line is grounded, the ignition module will switch to IC but, because the line is grounded, there will be no IC signal. A Code 42 will be set.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 42 means the ECM has seen an open or short to ground in the IC or bypass circuits. This test confirms Code 42 and that the fault causing the code is present.
2. Check for a normal IC ground path through the ignition module. An IC CKT 423 shorted to ground will also read more than 3000 ohms; however, this will be checked later.
3. As the test light voltage touches CKT 424, the module should switch, causing the DVM reading to go from over 3000 ohms to under 1000 ohms. The important thing is that the module "switched."
4. The module did not switch and this step checks for:
   - IC CKT 423 shorted to ground.
   - Bypass CKT 424 open.
   - Faulty ignition module connection or module.
5. Confirms that Coded 42 is a faulty ECM and not an intermittent in CKT 423 or CKT 4

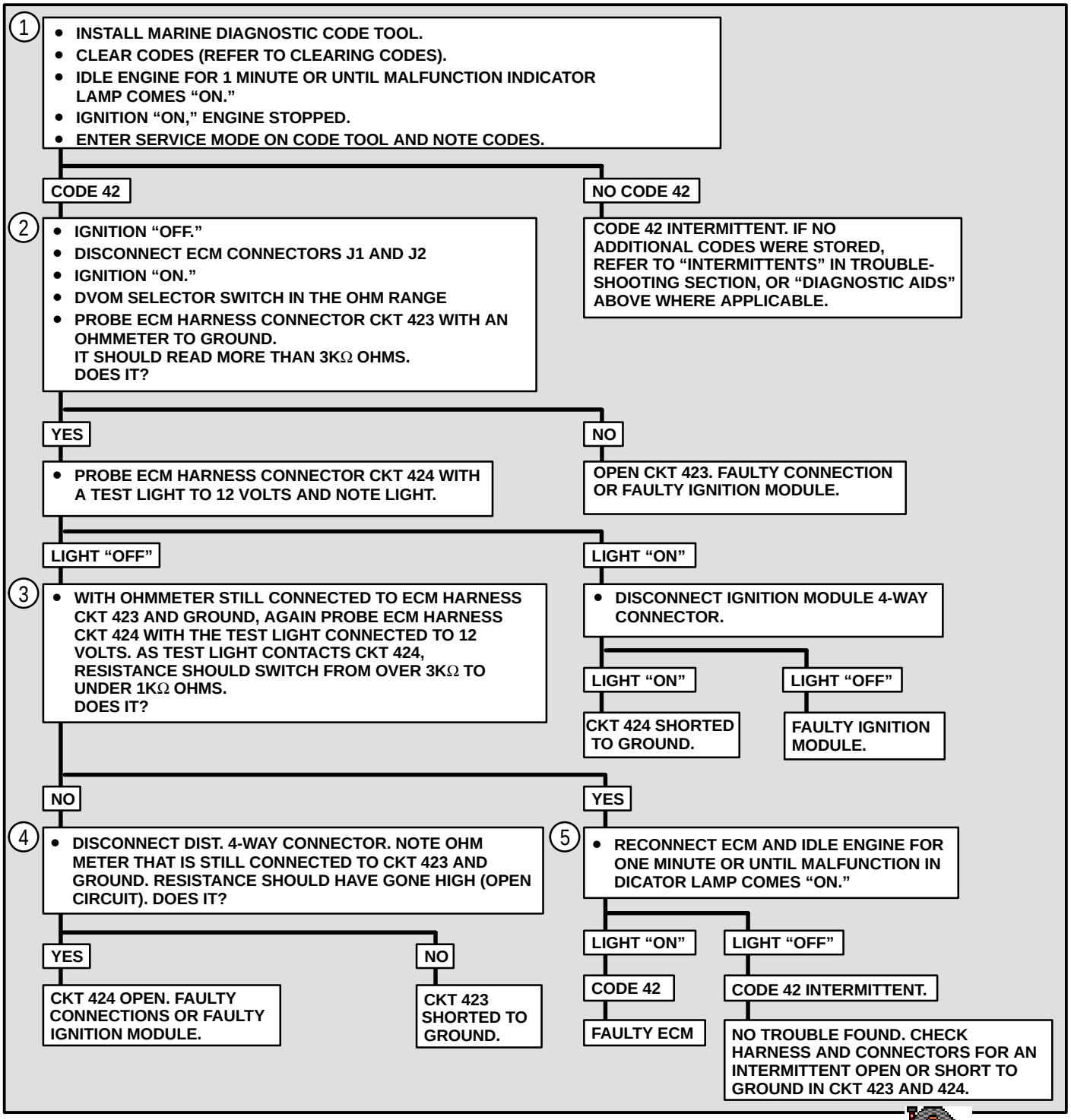
Index

Code 42: IC Circuit (Non-Scan) (2 of 2)

DIAGNOSTIC AIDS:

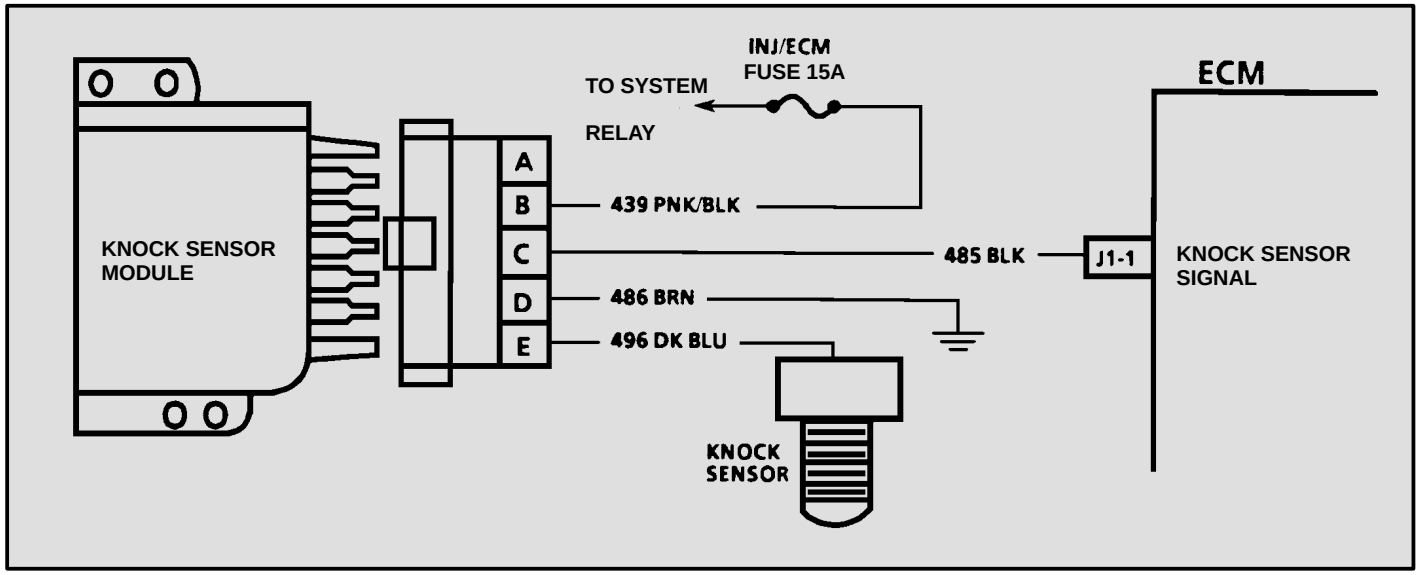
An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.


1
INSTALL MARINE DIAGNOSTIC CODE TOOL.
CLEAR CODES (REFER TO CLEARING CODES).
IDLE ENGINE FOR 1 MINUTE OR UNTIL MALFUNCTION INDICATOR LAMP COMES “ON.”
IGNITION “ON,” ENGINE STOPPED.
ENTER SERVICE MODE ON CODE TOOL AND NOTE CODES.
CODE 42
NO CODE 42
CODE 42 INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO “INTERMITTENTS” IN TROUBLE-SHOOTING SECTION, OR “DIAGNOSTIC AIDS” ABOVE WHERE APPLICABLE.
2
IGNITION “OFF.”
DISCONNECT ECM CONNECTORS J1 AND J2
IGNITION “ON.”
DVOM SELECTOR SWITCH IN THE OHM RANGE
PROBE ECM HARNESS CONNECTOR CKT 423 WITH AN OHMMETER TO GROUND.
IT SHOULD READ MORE THAN 3KΩ OHMS.
DOES IT?
YES
NO
PROBE ECM HARNESS CONNECTOR CKT 424 WITH A TEST LIGHT TO 12 VOLTS AND NOTE LIGHT.
OPEN CKT 423. FAULTY CONNECTION OR FAULTY IGNITION MODULE.
LIGHT “OFF”
LIGHT “ON”
3
WITH OHMMETER STILL CONNECTED TO ECM HARNESS CKT 423 AND GROUND, AGAIN PROBE ECM HARNESS CKT 424 WITH THE TEST LIGHT CONNECTED TO 12 VOLTS. AS TEST LIGHT CONTACTS CKT 424, RESISTANCE SHOULD SWITCH FROM OVER 3KΩ TO UNDER 1KΩ OHMS.
DOES IT?
DISCONNECT IGNITION MODULE 4-WAY CONNECTOR.
LIGHT “ON”
LIGHT “OFF”
CKT 424 SHORTED TO GROUND.
FAULTY IGNITION MODULE.
NO
YES
4
DISCONNECT DIST. 4-WAY CONNECTOR. NOTE OHM METER THAT IS STILL CONNECTED TO CKT 423 AND GROUND. RESISTANCE SHOULD HAVE GONE HIGH (OPEN CIRCUIT). DOES IT?
5
RECONNECT ECM AND IDLE ENGINE FOR ONE MINUTE OR UNTIL MALFUNCTION IN DICATOR LAMP COMES “ON.”
YES
NO
LIGHT “ON”
LIGHT “OFF”
CKT 424 OPEN. FAULTY CONNECTIONS OR FAULTY IGNITION MODULE.
CKT 423 SHORTED TO GROUND.
CODE 42
CODE 42 INTERMITTENT.
FAULTY ECM
NO TROUBLE FOUND. CHECK HARNESS AND CONNECTORS FOR AN INTERMITTENT OPEN OR SHORT TO GROUND IN CKT 423 AND 424.

Index

Code 43: Knock Sensor (KS) (Non-Scan)
(1 of 2)



CIRCUIT DESCRIPTION:

The ability to sense engine knock or detonation is accomplished with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the KS module to the ECM drops, and this signals the ECM to retard timing.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step ensures that the knock sensor circuitry is within the proper resistance value.
2. Applying 12 volts with a test light to CKT 496 simulates a signal from the knock sensor. The knock sensor is faulty if a response occurs.
3. This step checks if a voltage signal from the KS module is present at the ECM.
4. This step determines if ignition voltage is available to power up the KS module.
5. This step confirms the ability of the KS module to remove the voltage from the signal line when it sees spark knock. Since the knock sensor produces an AC voltage signal, it may be necessary to repeatedly touch the harness connector with the test light probe to simulate this type of signal.
6. This step checks the ground circuit from the KS module. If the test light is dim, check ground (CKT 486) for excessive resistance.

DIAGNOSTIC AIDS:

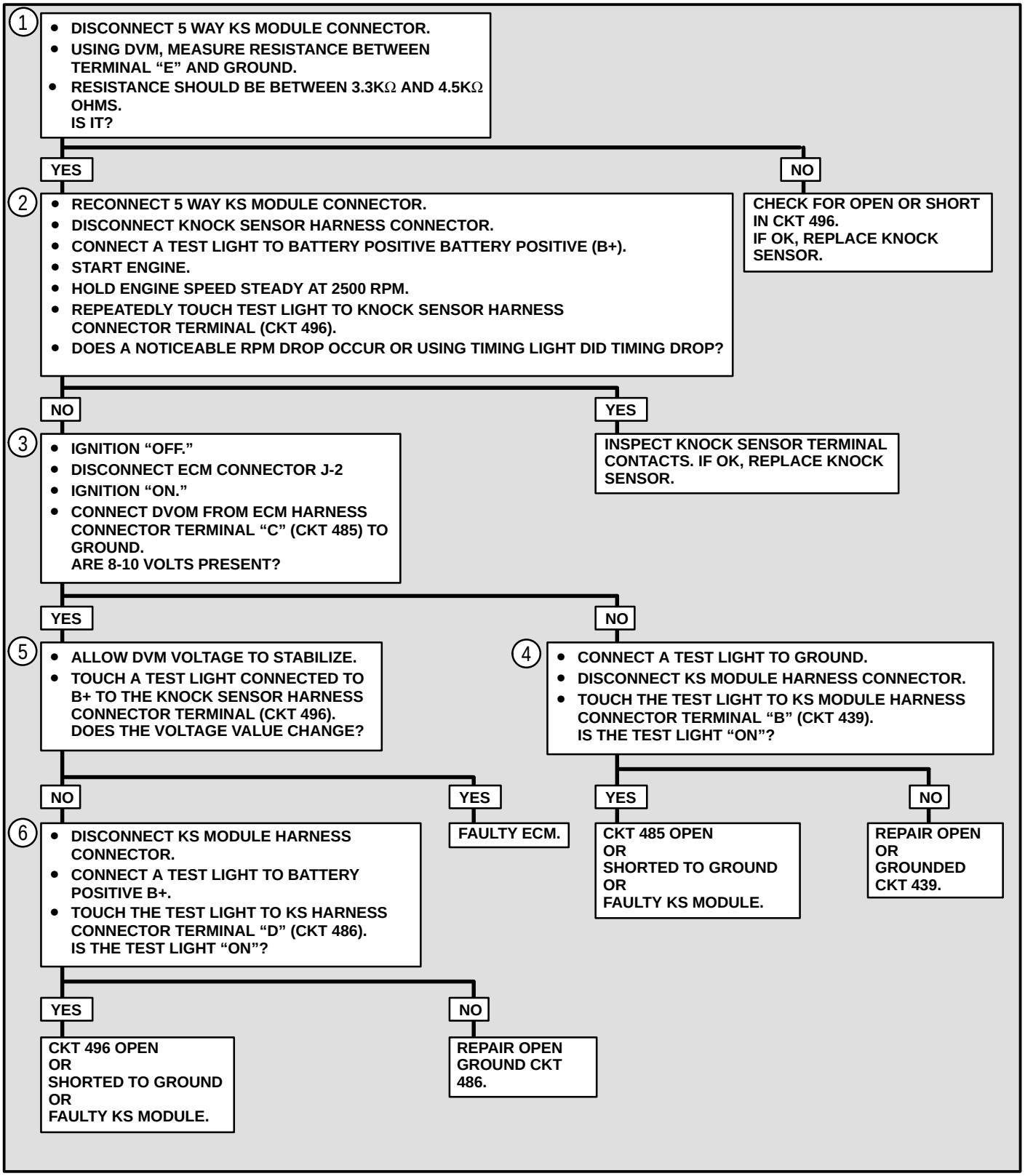
If CKT 496 is routed too close to secondary ignition wires, the KS module may see the interference as a knock signal, resulting in false retard.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

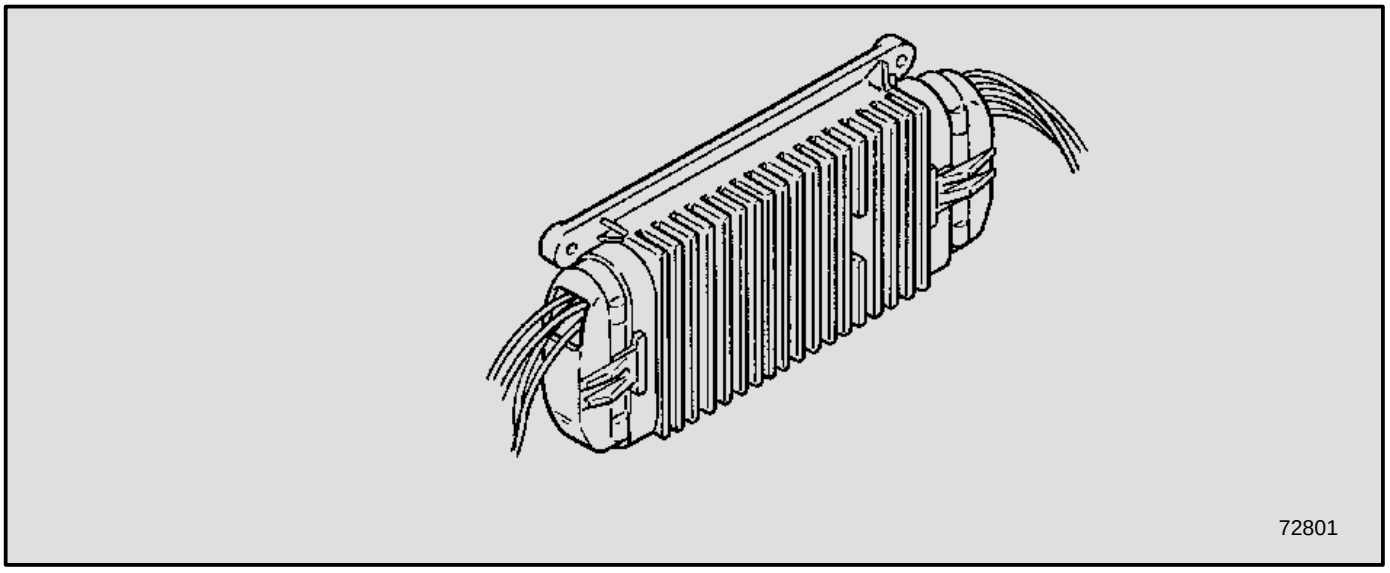
Index

Code 43: Knock Sensor (KS) Circuit (Non-Scan) (2 of 2)


1
DISCONNECT 5 WAY KS MODULE CONNECTOR.
USING DVM, MEASURE RESISTANCE BETWEEN TERMINAL "E" AND GROUND.
RESISTANCE SHOULD BE BETWEEN 3.3KΩ AND 4.5KΩ OHMS.
IS IT?
YES
NO
CHECK FOR OPEN OR SHORT IN CKT 496.
IF OK, REPLACE KNOCK SENSOR.
2
RECONNECT 5 WAY KS MODULE CONNECTOR.
DISCONNECT KNOCK SENSOR HARNESS CONNECTOR.
CONNECT A TEST LIGHT TO BATTERY POSITIVE BATTERY POSITIVE (B+).
START ENGINE.
HOLD ENGINE SPEED STEADY AT 2500 RPM.
REPEATEDLY TOUCH TEST LIGHT TO KNOCK SENSOR HARNESS CONNECTOR TERMINAL (CKT 496).
DOES A NOTICEABLE RPM DROP OCCUR OR USING TIMING LIGHT DID TIMING DROP?
NO
YES
INSPECT KNOCK SENSOR TERMINAL CONTACTS. IF OK, REPLACE KNOCK SENSOR.
3
IGNITION "OFF."
DISCONNECT ECM CONNECTOR J-2
IGNITION "ON."
CONNECT DVOM FROM ECM HARNESS CONNECTOR TERMINAL "C" (CKT 485) TO GROUND.
ARE 8-10 VOLTS PRESENT?
YES
NO
5
ALLOW DVM VOLTAGE TO STABILIZE.
TOUCH A TEST LIGHT CONNECTED TO B+ TO THE KNOCK SENSOR HARNESS CONNECTOR TERMINAL (CKT 496).
DOES THE VOLTAGE VALUE CHANGE?
4
CONNECT A TEST LIGHT TO GROUND.
DISCONNECT KS MODULE HARNESS CONNECTOR.
TOUCH THE TEST LIGHT TO KS MODULE HARNESS CONNECTOR TERMINAL "B" (CKT 439).
IS THE TEST LIGHT "ON"?
NO
YES
YES
NO
6
DISCONNECT KS MODULE HARNESS CONNECTOR.
CONNECT A TEST LIGHT TO BATTERY POSITIVE B+.
TOUCH THE TEST LIGHT TO KS HARNESS CONNECTOR TERMINAL "D" (CKT 486).
IS THE TEST LIGHT "ON"?
FAULTY ECM.
CKT 485 OPEN OR SHORTED TO GROUND OR FAULTY KS MODULE.
REPAIR OPEN OR GROUNDED CKT 439.
YES
NO
CKT 496 OPEN OR SHORTED TO GROUND OR FAULTY KS MODULE.
REPAIR OPEN GROUND CKT 486.

Index

Code 51: Calibration Memory Failure Non-Scan Diagnostics (1 of 2)



CIRCUIT DESCRIPTION:

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

This test is also used as a security measure to prevent improper use of calibrations or changes to these calibrations that may alter the designed function of the EFI system.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step checks to see if the fault is present during diagnosis. If present, the ECM is not functioning correctly and must be replaced.

IMPORTANT: At the time of printing, vessels with Fuel Injection were not being field reprogrammed to correct this failure. Replacement of the ECM with a factory reprogrammed ECM is necessary if Code 51 is current and resets when clearing codes is completed.

DIAGNOSTIC AIDS:

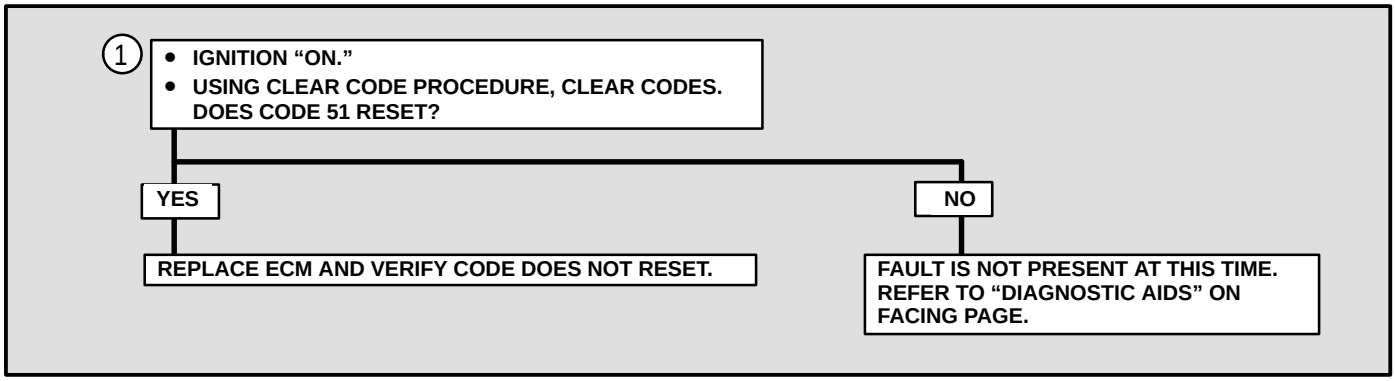
An intermittent Code 51 may be caused by a bad cell in the EEPROM that is sensitive to temperature changes. If Code 51 failed more than once, but is intermittent, replace ECM.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

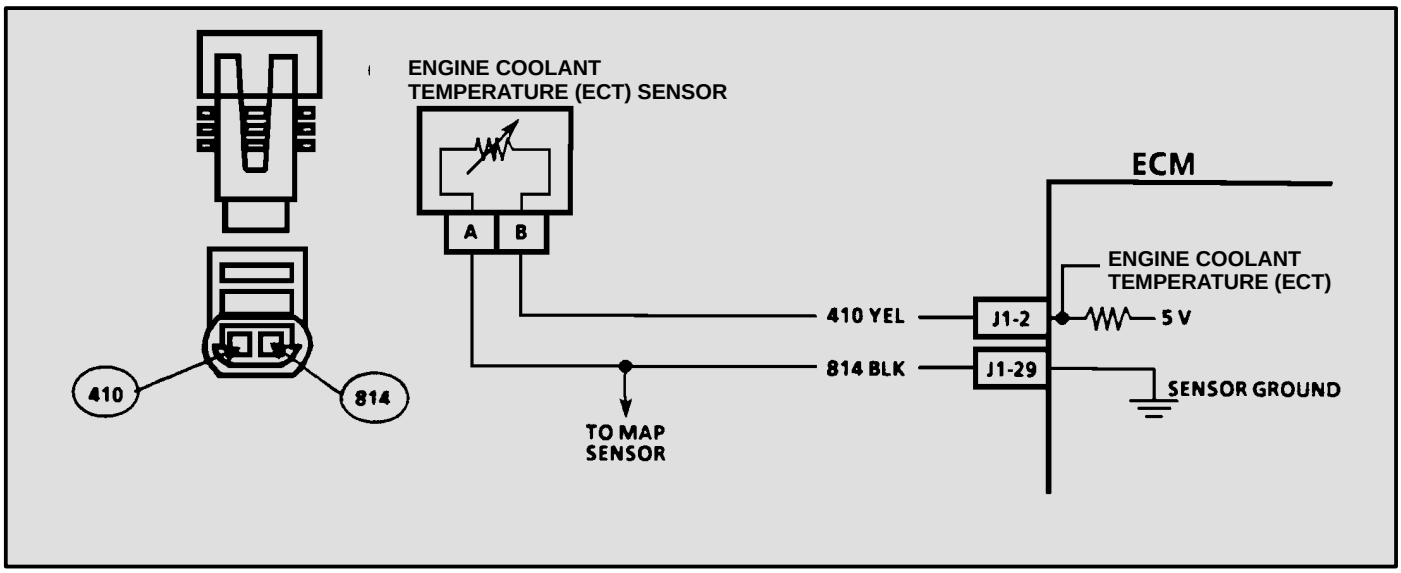
Index

Code 51: Calibration Memory Failure (Non-Scan) (2 of 2)


1
• IGNITION "ON."
• USING CLEAR CODE PROCEDURE, CLEAR CODES. DOES CODE 51 RESET?
YES
NO
REPLACE ECM AND VERIFY CODE DOES NOT RESET.
FAULT IS NOT PRESENT AT THIS TIME. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

Diagnostics - Using Scan Tool (Scan)

Code 14 Engine Coolant Temperature (ECT) Sensor Circuit (Scan) (1 of 2)



CIRCUIT DESCRIPTION:

The Engine Coolant Temperature (ECT) Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage. As the engine coolant warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature, 160-180°F (71-82°C), the voltage will measure about 1.5 to 2.0 volts.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 14 will set if:
   - Signal voltage indicates a coolant temperature above 266°F (130°C).
   - Signal voltage indicates a coolant temperature below –22°F (–30°C).
2. This test will determine if CKT 410 is shorted to ground, which will cause the condition for Code 14.

DIAGNOSTIC AIDS:

Check harness routing for a potential short to ground in CKT 410.

Scan tool displays engine temperature in degrees Fahrenheit and Celsius. After engine is started, the temperature should rise steadily, reach normal operating temperature, and then stabilize when thermostat opens.

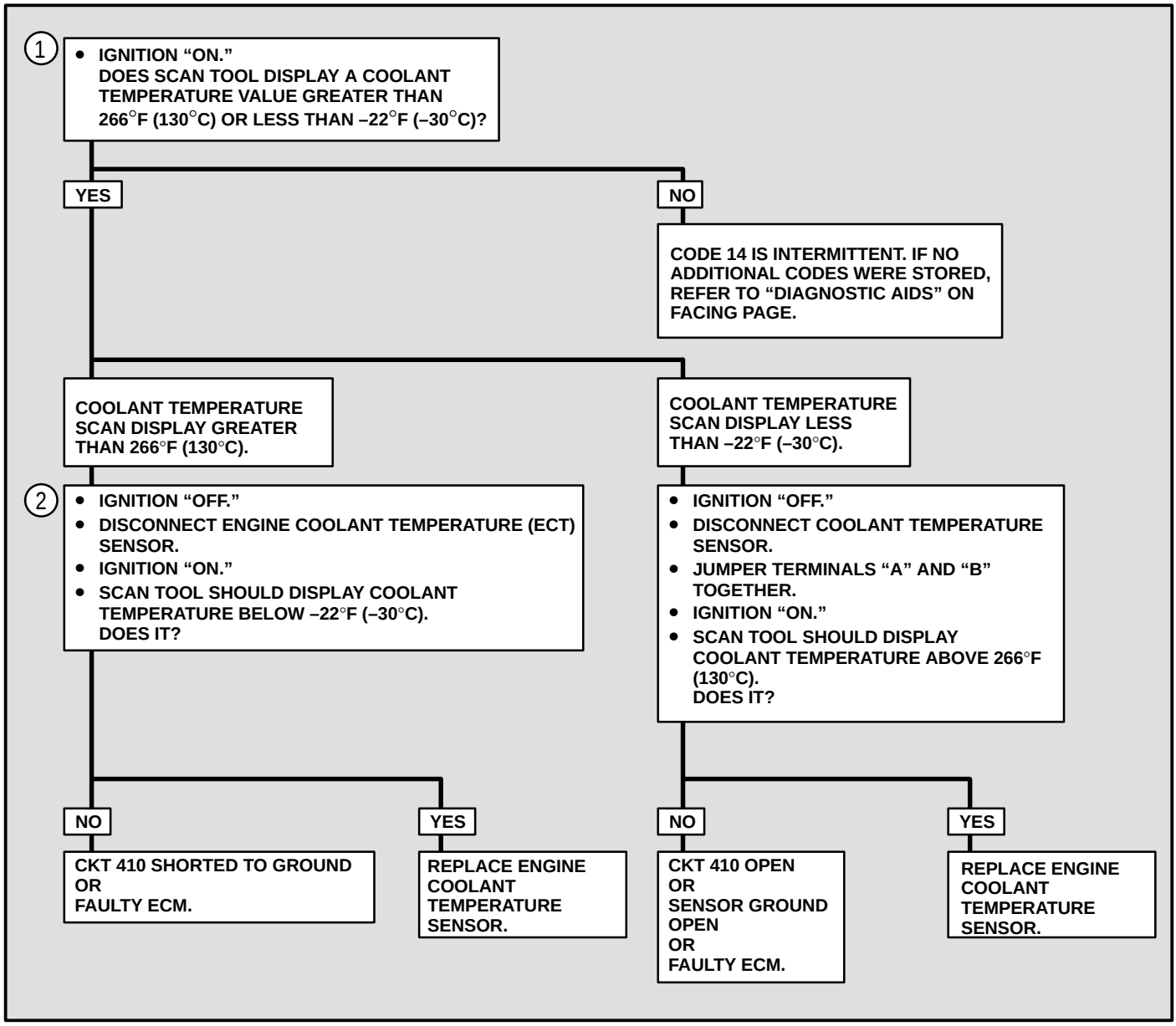
See “Intermittents” in “Troubleshooting.”

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

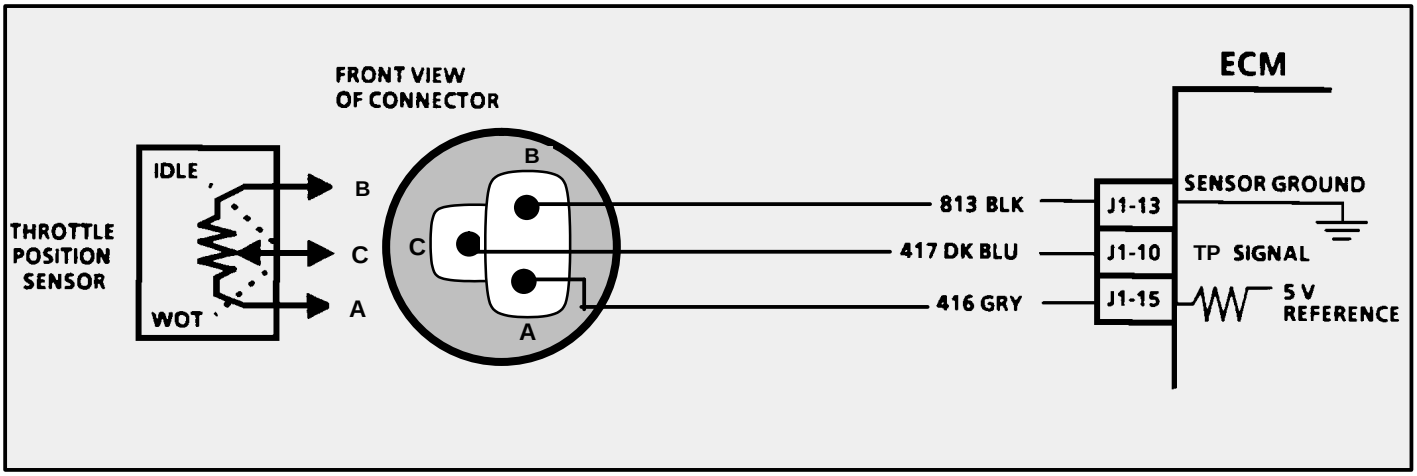
Index

Code 14: ECT Circuit (Scan)
(2 of 2)


1
• IGNITION "ON."
DOES SCAN TOOL DISPLAY A COOLANT TEMPERATURE VALUE GREATER THAN 266°F (130°C) OR LESS THAN –22°F (–30°C)?
YES
NO
CODE 14 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
COOLANT TEMPERATURE SCAN DISPLAY GREATER THAN 266°F (130°C).
COOLANT TEMPERATURE SCAN DISPLAY LESS THAN –22°F (–30°C).
2
• IGNITION "OFF."
• DISCONNECT ENGINE COOLANT TEMPERATURE (ECT) SENSOR.
• IGNITION "ON."
• SCAN TOOL SHOULD DISPLAY COOLANT TEMPERATURE BELOW –22°F (–30°C).
DOES IT?
• IGNITION "OFF."
• DISCONNECT COOLANT TEMPERATURE SENSOR.
• JUMPER TERMINALS "A" AND "B" TOGETHER.
• IGNITION "ON."
• SCAN TOOL SHOULD DISPLAY COOLANT TEMPERATURE ABOVE 266°F (130°C).
DOES IT?
NO
CKT 410 SHORTED TO GROUND
OR
FAULTY ECM.
YES
REPLACE ENGINE COOLANT TEMPERATURE SENSOR.
NO
CKT 410 OPEN
OR
SENSOR GROUND OPEN
OR
FAULTY ECM.
YES
REPLACE ENGINE COOLANT TEMPERATURE SENSOR.

Index

Code 21: Throttle Position (TP) Sensor Circuit (Scan) (1 of 2)



CIRCUIT DESCRIPTION:

The Throttle Position (TP) Sensor provides a voltage signal that changes as throttle blades open or close. Signal voltage should vary from about .7 volts at idle to about 4.5 volts at Wide Open Throttle (W.O.T.).

The TP signal is one of the most important inputs used by the Electronic Control Module (ECM) for fuel control and for most of the ECM controlled outputs.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. With throttle closed the TP sensor should read between .3 and .8 volt. If it does not, check throttle cable adjustment or for bent linkage.
2. With the TP sensor disconnected, the TP voltage should go low if the ECM and wiring are OK.
3. Probing CKT 813 with a DVOM to CKT 416 checks the sensor ground. A faulty sensor ground will cause a Code 21.

DIAGNOSTIC AIDS:

The scan tool reads throttle position in voltage and percentage of throttle blade opening. With ignition ON or at idle, TP signal voltage should read between .3 and .8 volt with the throttle closed, and increase at a steady rate as throttle is moved toward Wide Open Throttle (W.O.T.).

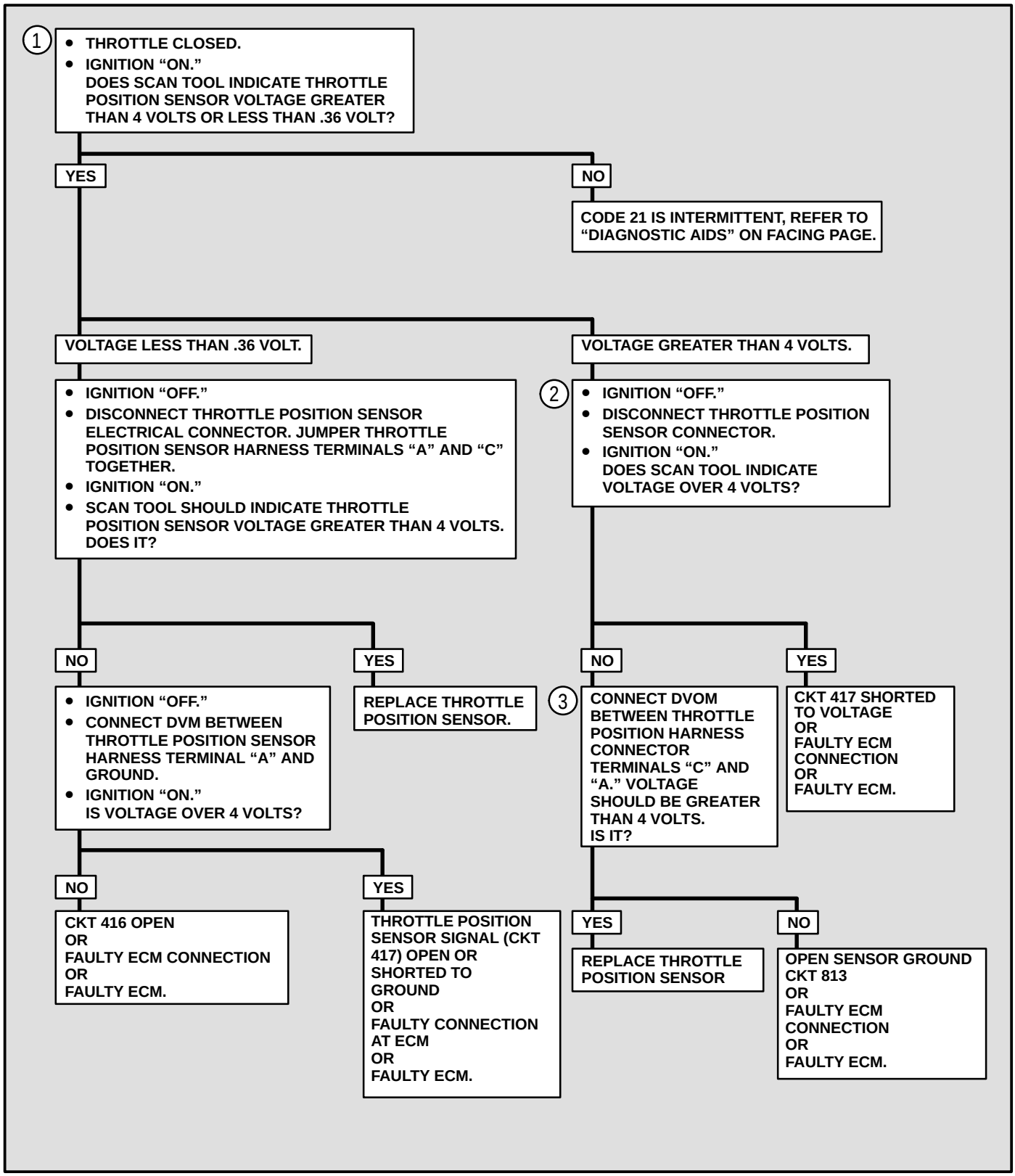
If Code 23 is also set, check CKT 813 for faulty wiring or connections. Check terminals at sensor for good contact.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

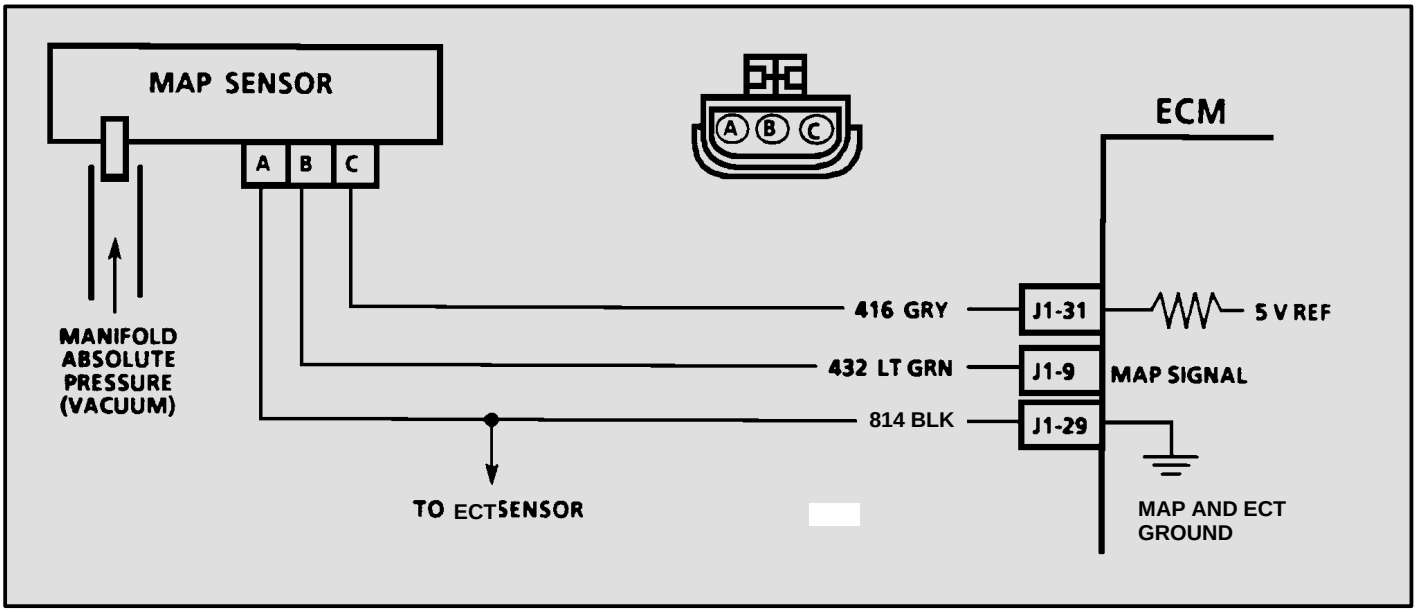
Index

Code 21: TP Sensor Circuit (Scan)
(2 of 2)


1
• THROTTLE CLOSED.
• IGNITION "ON."
DOES SCAN TOOL INDICATE THROTTLE POSITION SENSOR VOLTAGE GREATER THAN 4 VOLTS OR LESS THAN .36 VOLT?
YES
NO
CODE 21 IS INTERMITTENT, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
VOLTAGE LESS THAN .36 VOLT.
VOLTAGE GREATER THAN 4 VOLTS.
• IGNITION "OFF."
• DISCONNECT THROTTLE POSITION SENSOR ELECTRICAL CONNECTOR. JUMPER THROTTLE POSITION SENSOR HARNESS TERMINALS "A" AND "C" TOGETHER.
• IGNITION "ON."
• SCAN TOOL SHOULD INDICATE THROTTLE POSITION SENSOR VOLTAGE GREATER THAN 4 VOLTS. DOES IT?
2
• IGNITION "OFF."
• DISCONNECT THROTTLE POSITION SENSOR CONNECTOR.
• IGNITION "ON."
DOES SCAN TOOL INDICATE VOLTAGE OVER 4 VOLTS?
NO
YES
NO
YES
• IGNITION "OFF."
• CONNECT DVM BETWEEN THROTTLE POSITION SENSOR HARNESS TERMINAL "A" AND GROUND.
• IGNITION "ON."
IS VOLTAGE OVER 4 VOLTS?
REPLACE THROTTLE POSITION SENSOR.
3
CONNECT DVOM BETWEEN THROTTLE POSITION HARNESS CONNECTOR TERMINALS "C" AND "A." VOLTAGE SHOULD BE GREATER THAN 4 VOLTS.
IS IT?
CKT 417 SHORTED TO VOLTAGE
OR
FAULTY ECM CONNECTION
OR
FAULTY ECM.
NO
YES
YES
NO
CKT 416 OPEN
OR
FAULTY ECM CONNECTION
OR
FAULTY ECM.
THROTTLE POSITION SENSOR SIGNAL (CKT 417) OPEN OR SHORTED TO GROUND
OR
FAULTY CONNECTION AT ECM
OR
FAULTY ECM.
REPLACE THROTTLE POSITION SENSOR
OPEN SENSOR GROUND CKT 813
OR
FAULTY ECM CONNECTION
OR
FAULTY ECM.

Index

Code 33: Manifold Absolute Pressure (MAP) Sensor Circuit (Scan) (1 of 2)



CIRCUIT DESCRIPTION:

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1-1.5 volts at closed throttle idle, to 4.0-4.8 volts at Wide Open Throttle (W.O.T.) (low vacuum).

The scan tool displays manifold pressure in kPa of pressure and voltage. Low pressure (high vacuum) reads a low voltage while a high pressure (low vacuum) reads a high voltage.

If the MAP sensor fails, the ECM will substitute a fixed MAP value and use engine RPM to control fuel delivery.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Engine misfire or a low unstable idle may set Code 33. Disconnect MAP sensor and system will go into backup mode. If the misfire or idle condition remains, refer to “Troubleshooting.”
2. If the ECM recognizes the low MAP signal, the ECM and wiring are OK.

DIAGNOSTIC AIDS:

If the idle is rough or unstable, refer to “Troubleshooting” for items which can cause an unstable idle.

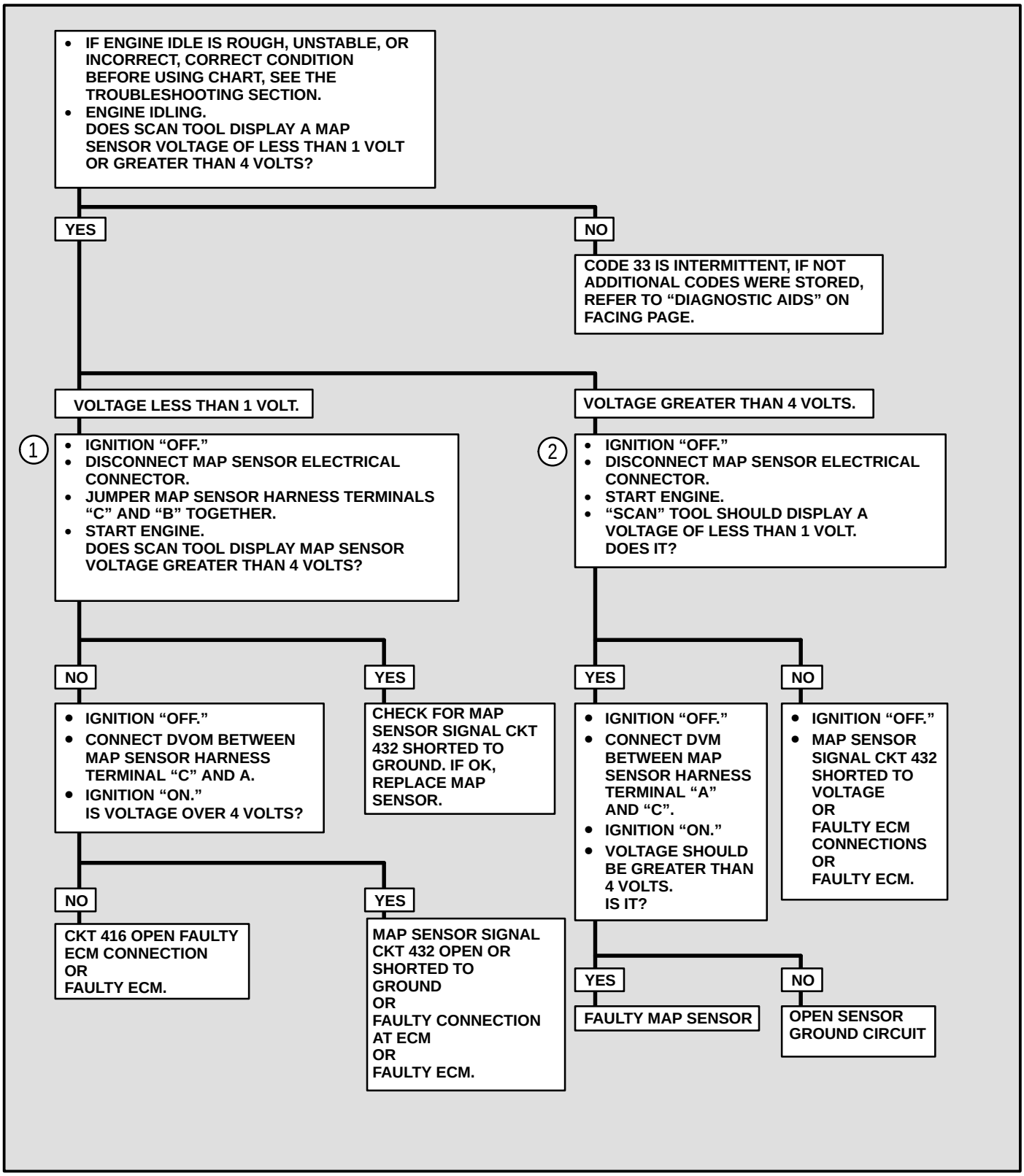
With the ignition ON and the engine OFF, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of vessel altitude and is referred to as BARO. Comparison of this BARO reading, with a known good vessel with the same sensor, is a good way to check accuracy of a “suspect” sensor. Reading should be the same, $\pm$ .4 volt.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

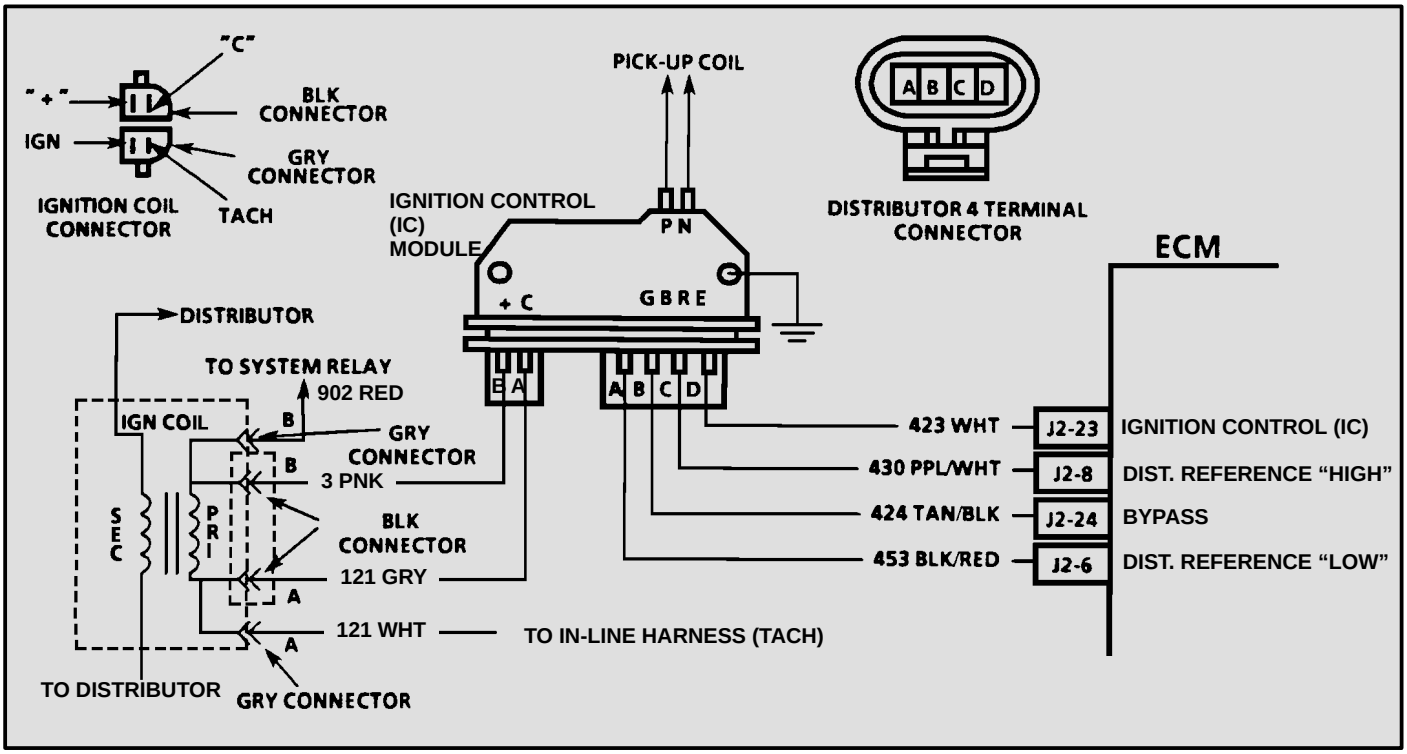
Index

Code 33: MAP Circuit (Scan) (2 of 2)


• IF ENGINE IDLE IS ROUGH, UNSTABLE, OR INCORRECT, CORRECT CONDITION BEFORE USING CHART, SEE THE TROUBLESHOOTING SECTION.
• ENGINE IDLING. DOES SCAN TOOL DISPLAY A MAP SENSOR VOLTAGE OF LESS THAN 1 VOLT OR GREATER THAN 4 VOLTS?
YES
NO
CODE 33 IS INTERMITTENT, IF NOT ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
VOLTAGE LESS THAN 1 VOLT.
VOLTAGE GREATER THAN 4 VOLTS.
1
• IGNITION "OFF."
• DISCONNECT MAP SENSOR ELECTRICAL CONNECTOR.
• JUMPER MAP SENSOR HARNESS TERMINALS "C" AND "B" TOGETHER.
• START ENGINE. DOES SCAN TOOL DISPLAY MAP SENSOR VOLTAGE GREATER THAN 4 VOLTS?
2
• IGNITION "OFF."
• DISCONNECT MAP SENSOR ELECTRICAL CONNECTOR.
• START ENGINE.
• "SCAN" TOOL SHOULD DISPLAY A VOLTAGE OF LESS THAN 1 VOLT. DOES IT?
NO
YES
YES
NO
• IGNITION "OFF."
• CONNECT DVOM BETWEEN MAP SENSOR HARNESS TERMINAL "C" AND A.
• IGNITION "ON." IS VOLTAGE OVER 4 VOLTS?
CHECK FOR MAP SENSOR SIGNAL CKT 432 SHORTED TO GROUND. IF OK, REPLACE MAP SENSOR.
• IGNITION "OFF."
• CONNECT DVM BETWEEN MAP SENSOR HARNESS TERMINAL "A" AND "C".
• IGNITION "ON."
• VOLTAGE SHOULD BE GREATER THAN 4 VOLTS. IS IT?
• IGNITION "OFF."
• MAP SENSOR SIGNAL CKT 432 SHORTED TO VOLTAGE OR FAULTY ECM CONNECTIONS OR FAULTY ECM.
NO
YES
YES
NO
CKT 416 OPEN FAULTY ECM CONNECTION OR FAULTY ECM.
MAP SENSOR SIGNAL CKT 432 OPEN OR SHORTED TO GROUND OR FAULTY CONNECTION AT ECM OR FAULTY ECM.
YES
NO
FAULTY MAP SENSOR
OPEN SENSOR GROUND CIRCUIT

Index

Code 42: Ignition Control (IC) Circuit (Scan) (1 Of 2)



CIRCUIT DESCRIPTION:

When the system is running on the ignition module, that is, no voltage on the bypass line, the ignition module grounds the IC signal. The ECM expects to detect a low voltage on the IC line during this condition. If it detects a voltage, it sets Code 42 and will not go into the IC mode.

When the RPM for IC is reached (about 300 RPM), and bypass voltage applied, the IC should no longer be grounded in the ignition module, so the IC voltage should be varying.

If the bypass line is open or grounded, the ignition module will not switch to IC mode so the IC voltage will be low and Code 42 will be set.

If the IC line is grounded, the ignition module will switch to IC but, because the line is grounded, there will be no IC signal. A Code 42 will be set.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. Code 42 means the ECM has seen an open or short to ground in the IC or bypass circuits. This test confirms Code 42 and that the fault causing the code is present.
2. Check for a normal IC ground path through the ignition module. An IC CKT 423 shorted to ground will also read more than 3000 ohms; however, this will be checked later.
3. As the test light voltage touches CKT 424, the module should switch, causing the DVOM reading to go from over 3000 ohms to under 1000 ohms. The important thing is that the module "switched."
4. The module did not switch and this step checks for:
   - IC CKT 423 shorted to ground.
   - Bypass CKT 424 open.
   - Faulty ignition module connection or module.
5. Confirms that Coded 42 is a faulty ECM and not an intermittent in CKT 423 or CKT 424.

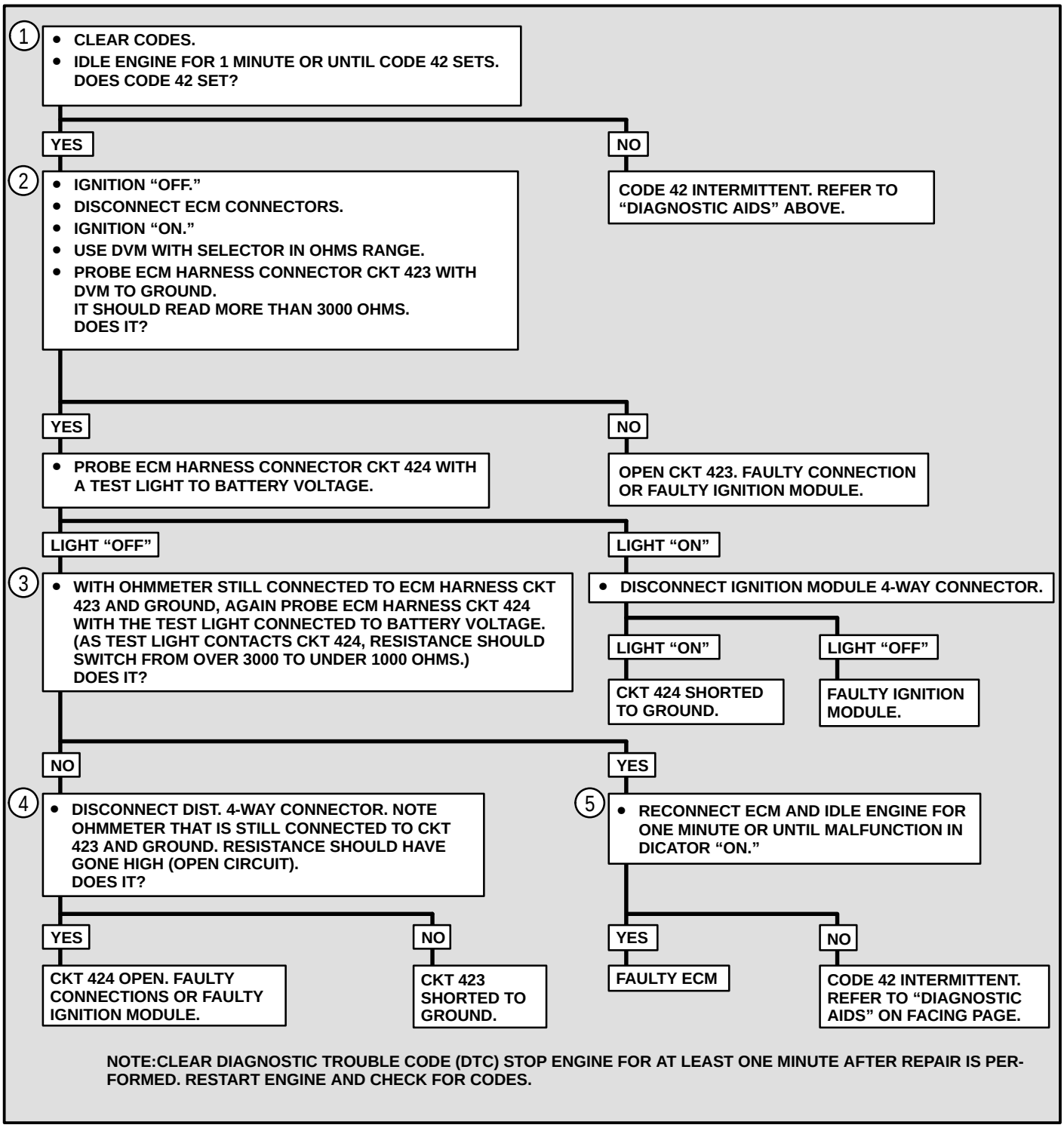
Index

DIAGNOSTIC AIDS:

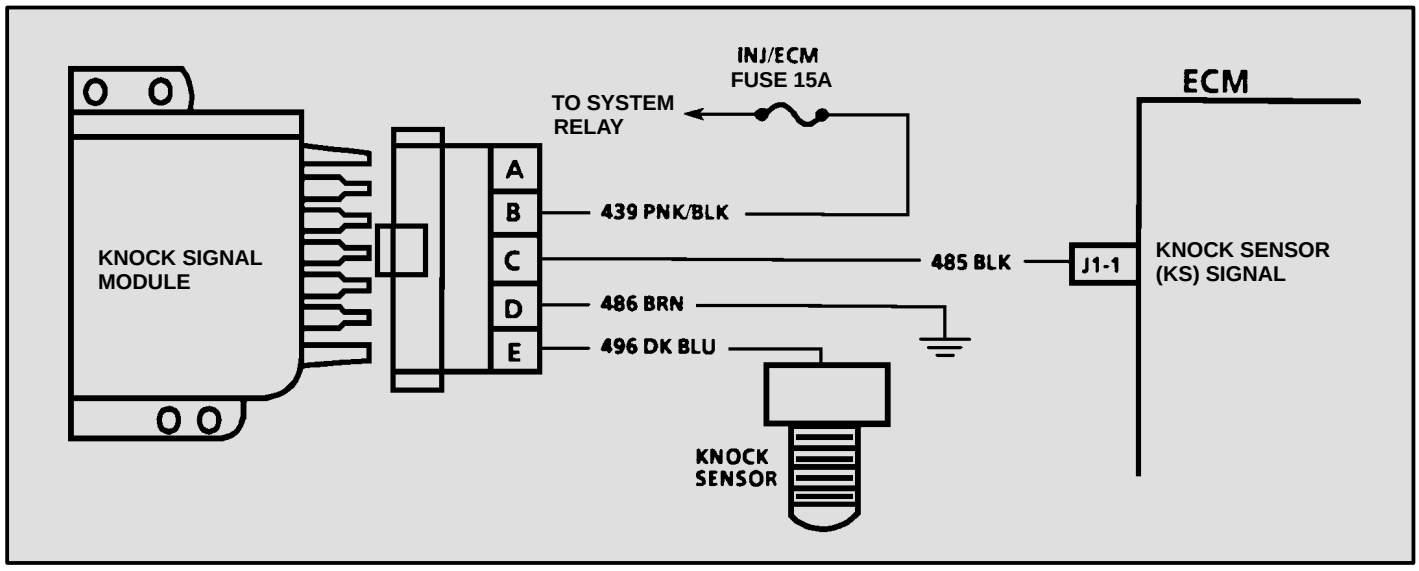
Refer to “Intermittents” in “Troubleshooting.”

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.


1
• CLEAR CODES.
• IDLE ENGINE FOR 1 MINUTE OR UNTIL CODE 42 SETS. DOES CODE 42 SET?
YES
NO
CODE 42 INTERMITTENT. REFER TO “DIAGNOSTIC AIDS” ABOVE.
2
• IGNITION “OFF.”
• DISCONNECT ECM CONNECTORS.
• IGNITION “ON.”
• USE DVM WITH SELECTOR IN OHMS RANGE.
• PROBE ECM HARNESS CONNECTOR CKT 423 WITH DVM TO GROUND. IT SHOULD READ MORE THAN 3000 OHMS. DOES IT?
YES
NO
• PROBE ECM HARNESS CONNECTOR CKT 424 WITH A TEST LIGHT TO BATTERY VOLTAGE.
OPEN CKT 423. FAULTY CONNECTION OR FAULTY IGNITION MODULE.
LIGHT “OFF”
LIGHT “ON”
3
• WITH OHMMETER STILL CONNECTED TO ECM HARNESS CKT 423 AND GROUND, AGAIN PROBE ECM HARNESS CKT 424 WITH THE TEST LIGHT CONNECTED TO BATTERY VOLTAGE. (AS TEST LIGHT CONTACTS CKT 424, RESISTANCE SHOULD SWITCH FROM OVER 3000 TO UNDER 1000 OHMS.) DOES IT?
• DISCONNECT IGNITION MODULE 4-WAY CONNECTOR.
LIGHT “ON”
LIGHT “OFF”
CKT 424 SHORTED TO GROUND.
FAULTY IGNITION MODULE.
NO
YES
4
• DISCONNECT DIST. 4-WAY CONNECTOR. NOTE OHMMETER THAT IS STILL CONNECTED TO CKT 423 AND GROUND. RESISTANCE SHOULD HAVE GONE HIGH (OPEN CIRCUIT). DOES IT?
5
• RECONNECT ECM AND IDLE ENGINE FOR ONE MINUTE OR UNTIL MALFUNCTION IN DICATOR “ON.”
YES
NO
YES
NO
CKT 424 OPEN. FAULTY CONNECTIONS OR FAULTY IGNITION MODULE.
CKT 423 SHORTED TO GROUND.
FAULTY ECM
CODE 42 INTERMITTENT. REFER TO “DIAGNOSTIC AIDS” ON FACING PAGE.
NOTE:CLEAR DIAGNOSTIC TROUBLE CODE (DTC) STOP ENGINE FOR AT LEAST ONE MINUTE AFTER REPAIR IS PERFORMED. RESTART ENGINE AND CHECK FOR CODES.

Code 43: Knock Sensor (KS) (Scan)
(1 Of 2)



CIRCUIT DESCRIPTION:

Sensing engine detonation or spark knock is accomplished with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the KS module to the ECM drops, and this signals the ECM to retard timing. The ECM will retard the timing when knock is detected and RPM is above a certain value.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step determines if there is a problem in the circuit. When an KS circuit fails, the ECM will switch to a default value of about 3.2 degrees of timing retard.
2. This step checks if there is a voltage source to the knock sensor from the KS module.
3. This step will determine if the knock sensor is faulty.

DIAGNOSTIC AIDS:

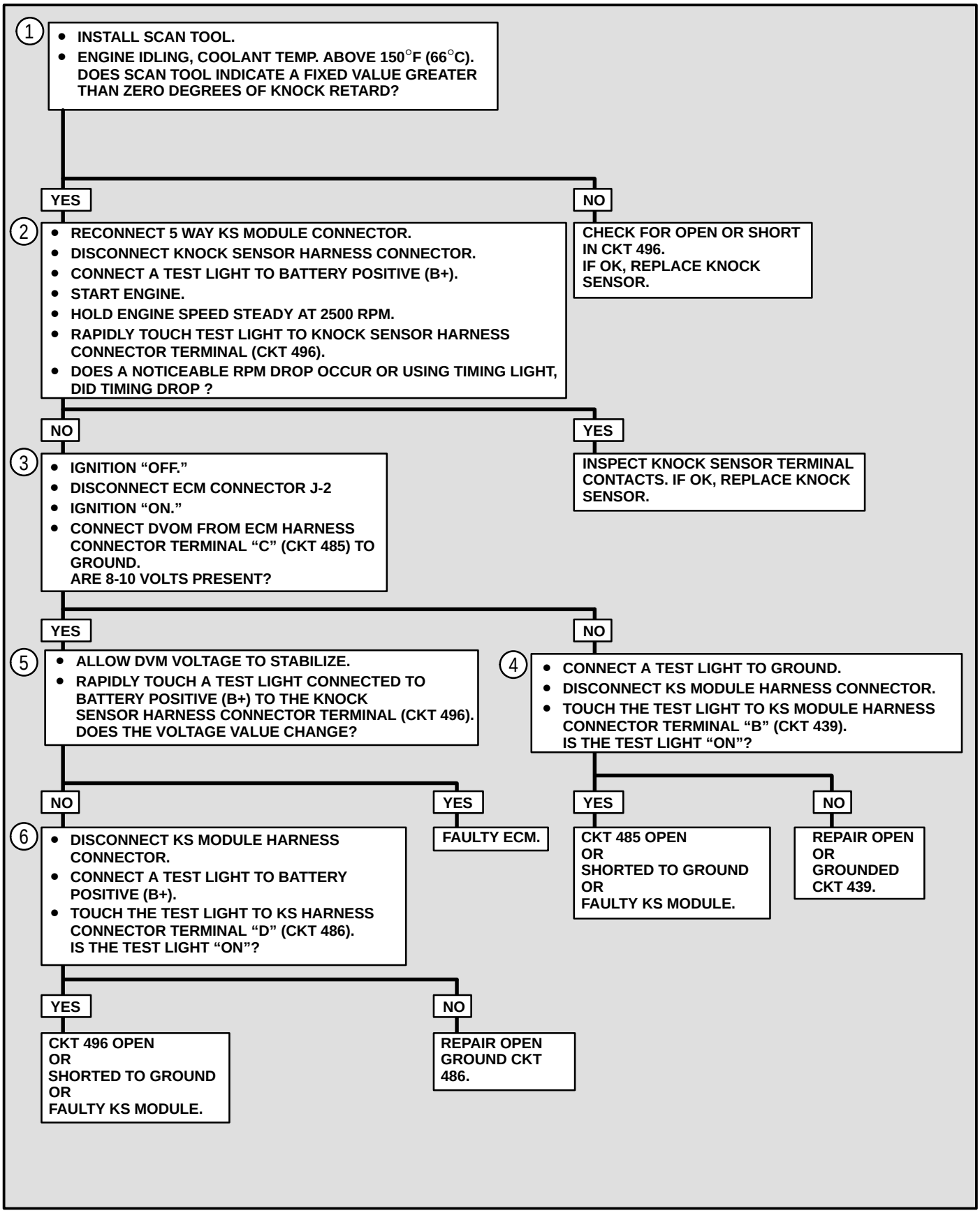
If CKT 496 is routed too close to secondary ignition wires, the KS module may see the interference as a knock signal, resulting in false retard.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

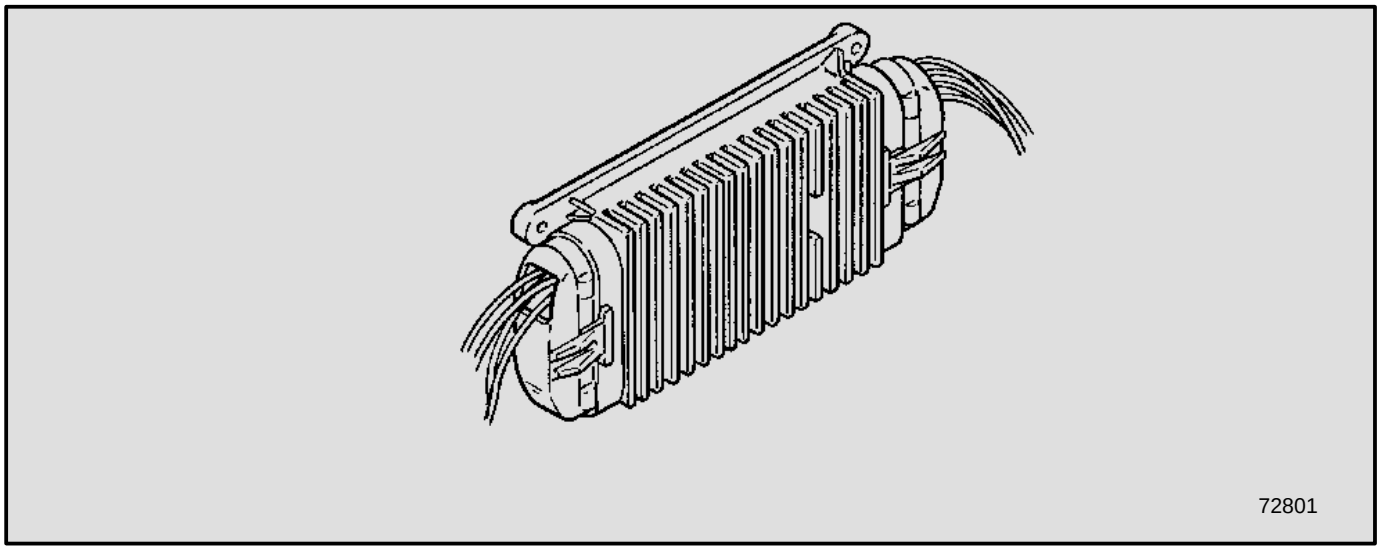
Index

Code 43: KS Circuit (Scan)
(2 of 2)


1
INSTALL SCAN TOOL.
ENGINE IDLING, COOLANT TEMP. ABOVE 150°F (66°C). DOES SCAN TOOL INDICATE A FIXED VALUE GREATER THAN ZERO DEGREES OF KNOCK RETARD?
YES
NO
2
RECONNECT 5 WAY KS MODULE CONNECTOR.
DISCONNECT KNOCK SENSOR HARNESS CONNECTOR.
CONNECT A TEST LIGHT TO BATTERY POSITIVE (B+).
START ENGINE.
HOLD ENGINE SPEED STEADY AT 2500 RPM.
RAPIDLY TOUCH TEST LIGHT TO KNOCK SENSOR HARNESS CONNECTOR TERMINAL (CKT 496).
DOES A NOTICEABLE RPM DROP OCCUR OR USING TIMING LIGHT, DID TIMING DROP ?
CHECK FOR OPEN OR SHORT IN CKT 496. IF OK, REPLACE KNOCK SENSOR.
NO
YES
3
IGNITION "OFF."
DISCONNECT ECM CONNECTOR J-2
IGNITION "ON."
CONNECT DVOM FROM ECM HARNESS CONNECTOR TERMINAL "C" (CKT 485) TO GROUND. ARE 8-10 VOLTS PRESENT?
INSPECT KNOCK SENSOR TERMINAL CONTACTS. IF OK, REPLACE KNOCK SENSOR.
YES
NO
5
ALLOW DVM VOLTAGE TO STABILIZE.
RAPIDLY TOUCH A TEST LIGHT CONNECTED TO BATTERY POSITIVE (B+) TO THE KNOCK SENSOR HARNESS CONNECTOR TERMINAL (CKT 496). DOES THE VOLTAGE VALUE CHANGE?
4
CONNECT A TEST LIGHT TO GROUND.
DISCONNECT KS MODULE HARNESS CONNECTOR.
TOUCH THE TEST LIGHT TO KS MODULE HARNESS CONNECTOR TERMINAL "B" (CKT 439). IS THE TEST LIGHT "ON"?
NO
YES
YES
NO
6
DISCONNECT KS MODULE HARNESS CONNECTOR.
CONNECT A TEST LIGHT TO BATTERY POSITIVE (B+).
TOUCH THE TEST LIGHT TO KS HARNESS CONNECTOR TERMINAL "D" (CKT 486). IS THE TEST LIGHT "ON"?
FAULTY ECM.
CKT 485 OPEN OR SHORTED TO GROUND OR FAULTY KS MODULE.
REPAIR OPEN OR GROUNDED CKT 439.
YES
NO
CKT 496 OPEN OR SHORTED TO GROUND OR FAULTY KS MODULE.
REPAIR OPEN GROUND CKT 486.

Index

Code 51: Calibration Memory Failure (Scan) (1 Of 2)



CIRCUIT DESCRIPTION:

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

This test is also used as a security measure to prevent improper use of calibrations or changes to these calibrations that may alter the designed function of EFI.

TEST DESCRIPTION:

Number(s) below refer to circled number(s) on the diagnostic chart.

1. This step checks to see if the fault is present during diagnosis. If present, the ECM is not functioning correctly and must be replaced.

IMPORTANT: At the time of printing, vessels with fuel injection were not being field reprogrammed to correct this failure. Replacement of the ECM with a factory reprogrammed ECM is necessary if Code 51 is current and resets when clearing codes is completed.

DIAGNOSTIC AIDS:

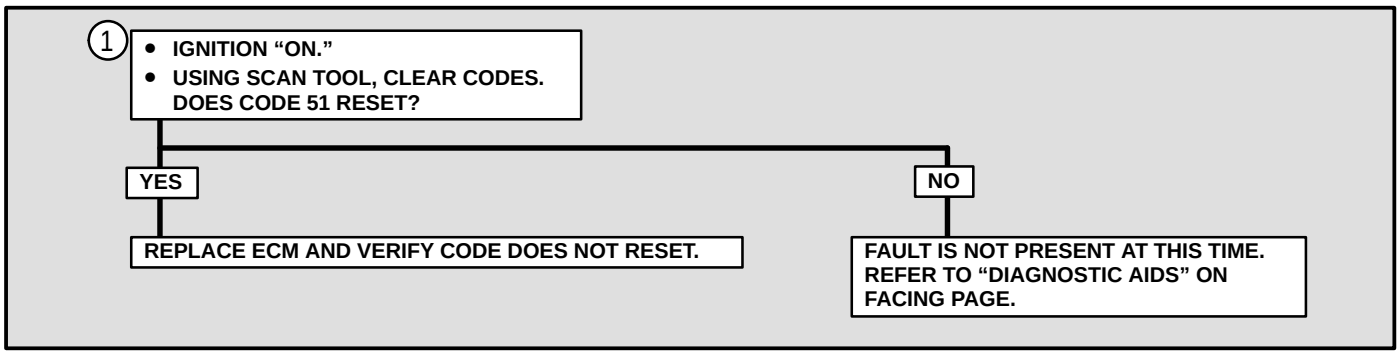
An intermittent Code 51 may be caused by a bad cell in the EEPROM that is sensitive to temperature changes. If Code 51 failed more than once, but is intermittent, replace ECM.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, a wire that is broken inside the insulation, or a corroded wire.

Any circuitry that is suspected as causing the intermittent complaint should be thoroughly checked for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, clear codes following “Clearing Codes” in “ECM Self-Diagnostics.” Failure to do so may result in codes not properly being cleared.

Index

Code 51: Calibration Memory Failure (Scan) (2 of 2)


1
IGNITION "ON."
USING SCAN TOOL, CLEAR CODES. DOES CODE 51 RESET?
YES
NO
REPLACE ECM AND VERIFY CODE DOES NOT RESET.
FAULT IS NOT PRESENT AT THIS TIME. REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

Troubleshooting

Changes In Terminology

Due to industry standardization of terminology for certain electronic engine controls some names and abbreviations have changed.

From	To
(CTS) Coolant Temperature Sensor	(ECT) Engine Coolant Temperature
(TPS) Throttle Position Sensor	(TP) Throttle Position
(EST) Electronic Spark Timing	(IC) Ignition Control
(ESC) Electronic Spark Control	(KS) Knock Sensor
(ALDL) Assembly Line Data Link	(DLC) Data Link Connector

Diagnostic Trouble Codes

Code Number	Code Description
Code 14	(ECT) Engine Coolant Temperature
Code 21	(TP) Throttle Position Sensor
Code 33	(MAP) Manifold Absolute Pressure
Code 42	(IC) Ignition Control
Code 43	(KS) Knock Sensor
Code 51	Calibration Memory Failure

Important Preliminary Checks

Before using this section, you should verify the customer complaint, and locate the correct symptom. Check the items indicated under that symptom.

Several of the following symptom procedures call for a careful visual/physical check.

The importance of this step cannot be stressed too strongly, it can lead to correcting a problem without further checks and can save valuable time.

1. Ensure that engine is in good mechanical condition.
2. Vacuum hoses for splits, kinks and proper connections
3. Air leaks at throttle body, plenum and intake manifold.
4. Ignition wires for cracking, hardness and proper routing.
5. Wiring for proper connections, pinches, and cuts. If wiring harness or connector repair is necessary.

Troubleshooting Charts

IMPORTANT PRELIMINARY CHECKS

BEFORE USING THIS SECTION

Before using this section you should have performed the “EFI Diagnostic Circuit Check” and determined that:

1. The ECM is operating correctly.
2. There are no diagnostic trouble codes (DTC) stored.

SYMPTOM

Verify the customer complaint, and locate the correct symptom. Check the items indicated under that symptom.

VISUAL/PHYSICAL CHECK

Several of the symptom procedures call for a careful visual/physical check. The importance of this step cannot be stressed too strongly. It can lead to correcting a problem without further checks and can save valuable time. These checks should include:

1. ECM grounds and sensors for being clean, tight and in their proper locations.
2. Vacuum hoses for splits, kinks, and proper connections. Check thoroughly for any type of leak or restriction.
3. Air leaks at throttle body mounting area and intake manifold sealing surfaces.
4. Ignition wires for cracking, hardness, proper routing and carbon tracking.
5. Wiring for proper connections, pinches and cuts.
6. Moisture in distributor cap, primary or secondary ignition circuit connections.
7. Salt corrosion on electrical connections and exposed throttle body linkages.
8. Ensure engine is in good mechanical condition.

INTERMITTENTS

Definition: Problem occurs randomly. May or may not store a Diagnostic Trouble Code (DTC).

DO NOT use the diagnostic trouble code charts for intermittent problems, unless instructed to do so. If a fault is intermittent, incorrect use of diagnostic trouble code charts may result in replacement of good parts.

Most intermittent problems are caused by faulty electrical connections or wiring. Perform careful check of suspected circuits for:

1. Poor mating of the connector halves or terminals not fully seated in the connector body (backed out or loose).
2. Improperly formed or damaged terminals and or connectors. All connector terminals and connectors in problem circuit should be carefully reformed or replaced to insure proper contact tension.
3. Poor terminal to wire connection (crimping).

An intermittent may be caused by:

1. Electrical system interference caused by a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.
2. Improper installation of electrical options, such as lights, ship to shore radios, sonar, etc.
3. Improperly routed knock sensor wires. Wires should be routed **AWAY** from spark plug wires, ignition and charging system components.
4. Secondary ignition shorted to ground.
5. Arching at spark plug wires, spark plugs or open ignition coil ground (coil mounting brackets). Part of internal circuitry shorted to ground such as in starters, relays and alternators.

If a visual/physical check does not find the cause of the problem, the fuel injection system can be tested with a voltmeter or a scan tool connected while observing the suspected circuit. An abnormal reading, when the problem occurs, indicates the problem may be in that circuit.

HARD START

Definition: Engine cranks OK, but does not start for a long time. Engine does eventually run, or may start but immediately dies.

PRELIMINARY CHECKS

Make sure proper starting procedure is being used. See Owner's Manual.

Perform the careful visual/physical checks as described at the start of "Troubleshooting Charts" section.

CHECK FUEL SYSTEM FOR:

1. Proper operation of fuel pump relay. Relay will operate fuel pump for 2 seconds when ignition is turned "ON." Also look for open in CKT 465, fuel pump relay driver.
2. Clogged or dirty water separating fuel filter.
3. Contaminated fuel or winter grade fuel during warm weather.
4. Vapor lock condition or engine flooding. Check fuel pressure.
5. Electric fuel pump check valve or fuel pressure regulator and / or fuel damper leaking.

CHECK IGNITION SYSTEM FOR:

1. Proper ignition timing.
2. Ignition wires for cracking, hardness and proper connections at both distributor cap and spark plugs.
3. Wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
4. Distributor cap inside and out for moisture, dust, cracks, burns, and arcing to coil mounting screws.
5. Worn distributor shaft. Bare and shorted wires. Pick-up coil resistance and connections. Try to turn distributor shaft by hand. Drive pin may be broken.

HARD START (continued)

CHECK SENSORS AND CONTROLS FOR:

1. Possible open in Engine Coolant Temperature (ECT) sensor and Manifold Absolute Pressure (MAP) sensor Ground CKT 814. Also may have set a DTC 14 and/or DTC 33.
2. Throttle Position (TP) sensor,ground CKT 813 could have a possible open and set DTC 21.
3. A sticking throttle shaft or binding linkage causes a high Throttle Position (TP) sensor voltage. Using a scan tool and/or voltmeter, TP sensor voltage should read less than .7 volt with throttle closed.
4. Proper Idle Air Control (IAC) operation.

CHECK ENGINE FOR:

1. Restricted exhaust.
2. Proper cylinder compression.
3. Proper camshaft timing/valve train problem.

SURGES

Definition: Engine power variation under steady throttle or cruise. Feels like the engine speeds up and slows down with no change in the throttle control.

PRELIMINARY CHECKS

Perform the visual/physical checks as described at the start of “Troubleshooting Charts” section.

CHECK FUEL SYSTEM FOR:

1. Fuel pressure to be within specification while condition exists.

CHECK IGNITION SYSTEM FOR:

1. Condition of 4-terminal Ignition Control (IC) connector at distributor. Connector wires must not be routed near spark plug wires.
2. Intermittent ground connection on ignition coil.
3. Proper operation (advancing or retarding) of Ignition Control (IC).
4. Condition of distributor cap, rotor, and spark plug wires.
5. Proper and clean connection on distributor pick-up coil terminal.
6. Spark plugs that may be fuel fouled, cracked, worn, improperly gapped, burned electrodes, or heavy deposits. Repair or replace as necessary.

CHECK SENSORS AND CONTROLS FOR:

1. Intermittent opens in Manifold Absolute Pressure (MAP) or Engine Coolant Temperature (ECT) sensor grounds CKT 814. If intermittent for a very brief period, will not set DTC.
2. Intermittent short to grounds or opens in Manifold Absolute Pressure (MAP) sensor 5 volt reference CKT 416 and Manifold Absolute Pressure (MAP) sensor signal CKT 432. If intermittent for a very brief period, will not set DTC.

SURGES (continued)

ADDITIONAL CHECKS FOR:

1. Proper alternator output voltage.
2. Leaks or kinks in vacuum lines.
3. Power reduction mode activated (if equipped)
4. Clean and tight ECM grounds and in their proper locations.

HESITATION, SAG OR STUMBLE

Definition: Momentary lack of response as the throttle is opened. Can occur at all engine speeds. May cause engine to stall if severe enough.

PRELIMINARY CHECKS

Perform the visual/physical checks as described at the start of “Troubleshooting Charts” section.

CHECK FUEL SYSTEM FOR:

1. Water contaminated fuel and dirty or restricted fuel filter
2. Fuel pressure within specification.
3. Proper functioning of fuel injectors.
4. Worn throttle linkage.

CHECK IGNITION SYSTEM FOR:

1. Ignition Control (IC) system for proper timing and advancing.
2. Faulty spark plug wires, fouled or improperly gapped spark plugs.
3. Knock Sensor (KS) system operational.

HESITATION, SAG OR STUMBLE (continued)

CHECK SENSORS AND CONTROLS FOR:

1. Binding or sticking Throttle Position (TP) sensor or salt corrosion. Throttle Position (TP) sensor voltage should increase as throttle is moved toward Wide Open Throttle (WOT).
2. Throttle Position (TP) sensor-5 volt reference CKT 416 for open, DTC 21 may be set.
3. Throttle Position (TP) sensor circuit for open or grounds, DTC 21 may be set.
4. Manifold Absolute Pressure (MAP) output voltage check.
5. Coolant sensor out of specification (Hi or low)

ADDITIONAL CHECKS

1. Proper alternator output voltage.
2. Faulty or incorrect thermostat.
3. Throttle linkage sticking, binding, or worn.

DETONATION/SPARK KNOCK

Definition: A mild to severe ping, usually worse under acceleration or heavy load. The engine makes sharp metallic knocks that change with throttle opening.

PRELIMINARY CHECKS

Perform the visual/physical checks as described at the start of “Troubleshooting Charts” section.

CHECK FUEL SYSTEM FOR:

1. Contaminated fuel.
2. Poor fuel quality and proper octane rating.
3. Fuel pressure within specification.

CHECK IGNITION SYSTEM FOR:

1. Proper ignition timing.
2. Proper operation of Knock Sensor (KS) system. Ensure wires are routed **AWAY** from secondary or primary ignition wires.
3. Ignition system ground.
4. Proper heat range and gapped spark plugs.
5. Incorrect knock sensor or knock sensor module.

CHECK SENSORS AND CONTROLS FOR:

1. Engine Coolant temperature (ECT) has shifted value.
2. Binding or sticking Throttle Position (TP) sensor or salt corrosion. Voltage should increase as throttle is moved toward Wide Open Throttle (WOT).

DETONATION/SPARK KNOCK (continued)

CHECK ENGINE FOR:

1. Low oil level.
2. Excessive oil in the combustion chamber. Valve seals for leaking.
3. Perform a compression test.
4. Combustion chambers for excessive carbon build-up. Remove carbon with top engine cleaner.
5. Proper camshaft timing.
6. Incorrect basic engine parts such as cam, heads, pistons, etc.

LACK OF POWER, SLUGGISH OR SPONGY

Definition: Engine delivers less than expected power. Little or no increase in speed when throttle control is moved toward Wide Open Throttle (WOT).

PRELIMINARY CHECKS

Perform the careful visual/physical checks as described at the start of “Troubleshooting Charts” section.

Remove flame arrestor and check for dirt, or for being plugged. Replace as necessary.

CHECK FUEL SYSTEM FOR:

1. Dirty or plugged water separating fuel filter.
2. Contaminated fuel
3. Possible open in injector driver CKTs 467 or 468.
4. Improper fuel pressure.

CHECK IGNITION SYSTEM FOR:

1. Proper initial engine timing.
2. Secondary ignition voltage.
3. Proper operation of Ignition Control (IC)/Knock Sensor (KS),open or short to ground in CKT 423 or 485 will set a DTC 42 or 43.

LACK OF POWER, SLUGGISH OR SPONGY (continued)

CHECK SENSORS AND CONTROLS FOR:

1. Possible open in Engine Coolant Temperature (ECT) and Manifold Absolute Pressure (MAP) sensors (Ground CKT 814). Also could have and set a DTC 14 and/or 33.
2. Throttle Position (TP) sensor circuit if DTC 21 set for open or grounds.
3. Using a scan tool and/or voltmeter record Throttle Position (TP) sensor voltage. It should read less than .7 volt with throttle closed or at idle position. A sticky throttle shaft or binding linkage causes a high voltage
4. Diagnostic test CKT 451 for being grounded, (maximum RPMs be will lower).

CHECK ENGINE FOR:

1. Restricted exhaust system.
2. Proper cylinder compression.
3. Proper valve timing and worn camshaft.

ADDITIONAL CHECKS:

1. Proper alternator output voltage..
2. Clean, tight and properly located ECM grounds.
3. Excessive resistance on bottom of boat (dirt, barnacles, etc.).
4. Proper size and pitch propeller for application.

CUTS OUT AND MISSES

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of the “Troubleshooting Charts” section

CHECK IGNITION SYSTEM FOR:

1. Cylinder miss

   a. Start engine, allow engine to stabilize, record RPM, then disconnect IAC motor. Stop engine, ground one spark plug wire at a time. Restart engine and record RPM.

   b. If there is an RPM drop on all cylinders, go to “Stalling, Rough, or Incorrect Idle” section. With engine “OFF” reconnect IAC motor

   c. If there is no RPM drop on one or more cylinders, or excessive variation in RPM drop, check for spark on the suspected cylinder(s).

   d. If there is a spark, remove spark plug(s) in these cylinders and check for: Insulation cracks, insulator cracks,wear, improper gap, burned electrodes, heavy deposits.

   e. Spark plug wire resistance (should not exceed 30,000 ohms).

   f. Faulty ignition coil.

   g. With engine running, spray distributor cap and spark plug wires with a fine mist of water to check for shorts.

CHECK FUEL SYSTEM FOR:

1. Contaminated or restricted water separating fuel filter.

2. Fuel pressure within specification.

3. Faulty fuel injectors.

CUTS OUT AND MISSES (continued)

CHECK SENSORS AND CONTROLS FOR:

1. Open or grounds in CKT 417 Throttle Position (TP) sensor signal.
2. Open or grounds in CKT 416 Throttle Position (TP) sensor 5 volt reference.

CHECK ENGINE MECHANICAL FOR:

1. Proper cylinder compression.
2. Bent push rods, worn rocker arms, broken valve springs, worn camshaft lobes. Repair or replace as necessary.

ADDITIONAL CHECKS:

A miss-fire can be caused by Electromagnetic Interference (EMI) on the reference circuit. EMI can usually be detected by monitoring engine RPM with a scan tool or a tachometer. A sudden increase in RPM with little change in actual engine RPM change, indicates EMI is present. If the problem exists, check routing of secondary wires, check ground circuit.

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING

Definition: Engine runs unevenly or rough at idle, also the idle may vary in RPM (called hunting). Either condition may be severe enough to cause stalling. Engine idles at incorrect speed.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of"Troubleshooting Charts" section.

CHECK FUEL SYSTEM FOR:

1. Open in CKTs 467 or 468.
2. Fuel injector(s) leaking.

CHECK IGNITION SYSTEM FOR:

1. Correct ignition timing
2. Possible opens in the following circuits, CKTs 424,430 and 423.
3. Possible short to ground in the following circuits, CKTs 430, 424, and 423.
4. Faulty spark plugs, wires, etc.

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING (continued)

CHECK SENSORS AND CONTROLS FOR:

1. Proper Idle Air Control (IAC) operation.
2. Possible open the in following circuits for CKTs 410, 417, 416, 813 and 814.
3. Possible short to ground in CKT 417, Throttle Position (TP) sensor signal, CKT 416 Throttle Position (TP) sensor 5 volt reference and CKT 451 diagnostic test circuit.
4. A sticking throttle shaft, binding linkage or salt corrosion will cause a high Throttle Position (TP) sensor voltage (open throttle indication), the ECM will not control idle. Using a scan tool or voltmeter record Throttle Position (TP) sensor voltage. It should read approximately .7 volt closed throttle and approximately 4.5 volts at Wide Open Throttle (WOT).

CHECK ENGINE FOR:

1. Proper cylinder compression.
2. Proper camshaft or weak valve springs

ADDITIONAL CHECKS:

1. Sticking or binding throttle linkage and salt corrosion.
2. Proper alternator output voltage.
3. Battery cables and ground straps should be clean and secure. Erratic voltage will cause Idle Air Control (IAC) to change its position, resulting in poor idle quality.

BACKFIRE (INTAKE)

Definition: Fuel ignites in the manifold, making a loud popping noise.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of “Troubleshooting Charts” section.

CHECK FUEL SYSTEM FOR:

1. An abnormal fuel system condition: If necessary perform fuel system diagnosis.
2. Properly functioning fuel injectors.

CHECK IGNITION SYSTEM FOR:

1. Opens and grounds in CKTs 423, 424 and 430.
2. Proper output voltage of ignition coil.
3. Cross-fire between spark plugs, (distributor cap, spark plug wires and proper routing of plug wires).
4. Faulty or corroded spark plug wires and boots.
5. Faulty spark plugs.

CHECK ENGINE FOR:

1. Sticking or leaking valves.
2. Proper valve timing, broken or worn valve train parts.

BACKFIRE (EXHAUST)

Definition: Fuel ignites in the manifold, making a loud popping noise.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of “Troubleshooting” section.

CHECK FUEL SYSTEM FOR:

1. An abnormal fuel system condition: If necessary perform fuel system diagnosis.
2. Proper functioning of fuel injectors.

CHECK IGNITION SYSTEM FOR:

1. Opens and grounds in CKTs 423, 424 and 430.
2. Properly functioning (advancing and retarding of timing) Ignition Control (IC).
3. Proper output voltage of ignition coil.
4. Faulty or corroded spark plug wires and boots.
5. Faulty spark plugs.

CHECK ENGINE FOR:

1. Possible sticking or leaking valves.

DIESELING, RUN-ON

Definition: Engine continues to run after key is turned "OFF," but runs very roughly. If engine runs smoothly, check ignition switch and adjustment.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of"Troubleshooting" section.

CHECK FUEL SYSTEM FOR:

1. Leaking injectors.

CHECK IGNITION SYSTEM FOR:

1. Properly functioning (advancing and retarding of timing) Ignition Control (IC).
2. Correct heat range spark plugs.
3. Proper operation of system relay.

CHECK COOLING SYSTEM FOR:

1. Faulty or incorrect thermostat.
2. Cooling system restriction causing overheating.
3. Loose belts.

POOR FUEL ECONOMY

Definition: Fuel economy is noticeably lower than expected.

PRELIMINARY CHECKS

Perform the important preliminary checks as described at the start of “Troubleshooting” section.

1. Operator’s driving habits.
2. Dirty or plugged flame arrestor.
3. Fuel leaks.

CHECK FUEL SYSTEM FOR:

1. Quality and type of fuel.
2. Fuel pressure within specification.

CHECK IGNITION SYSTEM FOR:

1. Correct base timing
2. Properly functioning (advancing and retarding of timing) Ignition Control (IC).
3. Fuel fouled, cracked, worn, improperly gapped spark plugs, burned electrodes, or heavy deposits. Repair or replace as necessary.
4. Knock sensor system operation.

POOR FUEL ECONOMY (continued)

CHECK SENSORS AND CONTROLS FOR:

1. If MAP, TP, or Coolant Sensor are erratic there will be poor economy.

CHECK ENGINE FOR:

1. Proper cylinder compression.

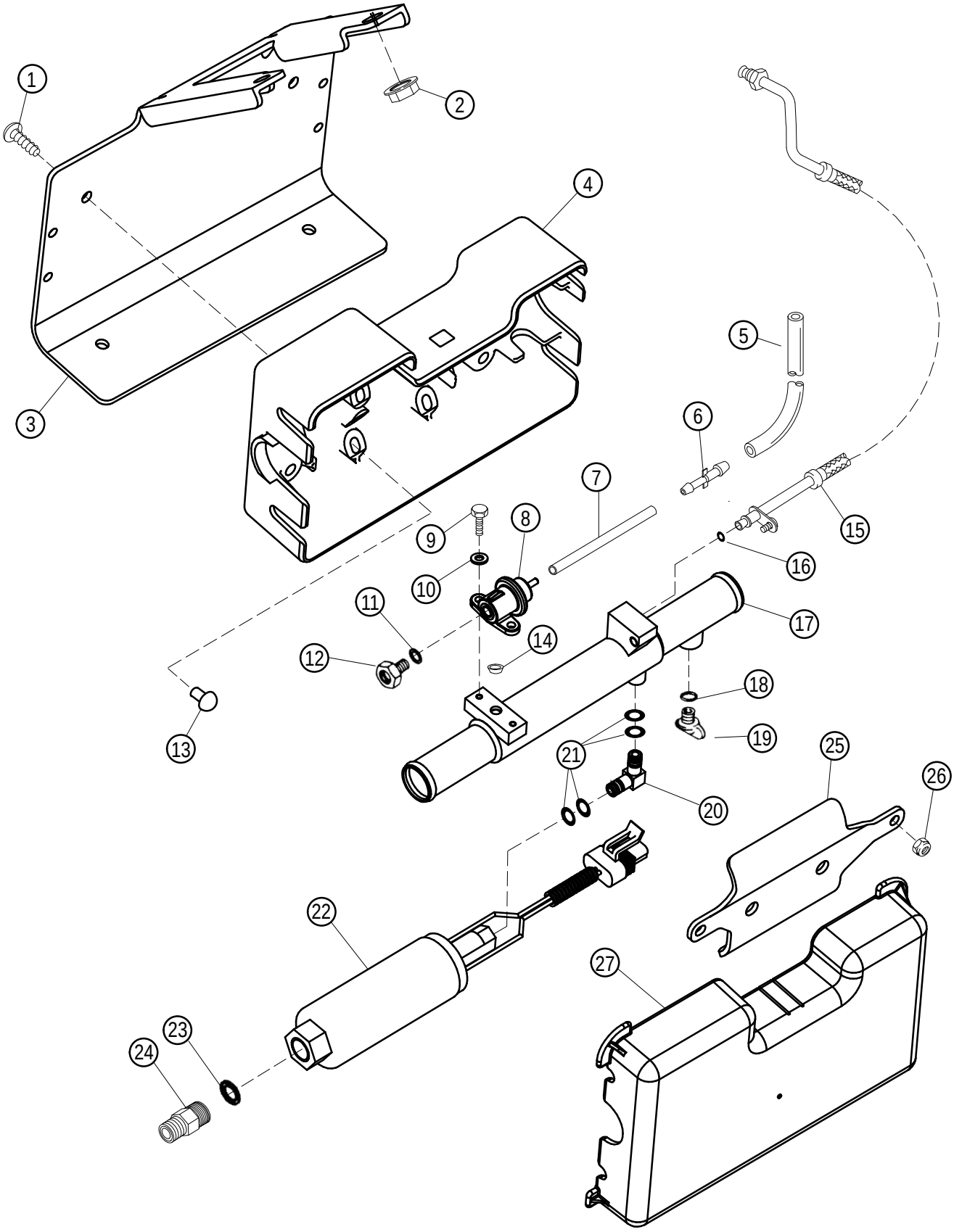
1. Exhaust system restriction.

2. Excessive resistance on bottom of boat (dirt, barnacles, etc.)

3. Proper size and pitch propeller for application.

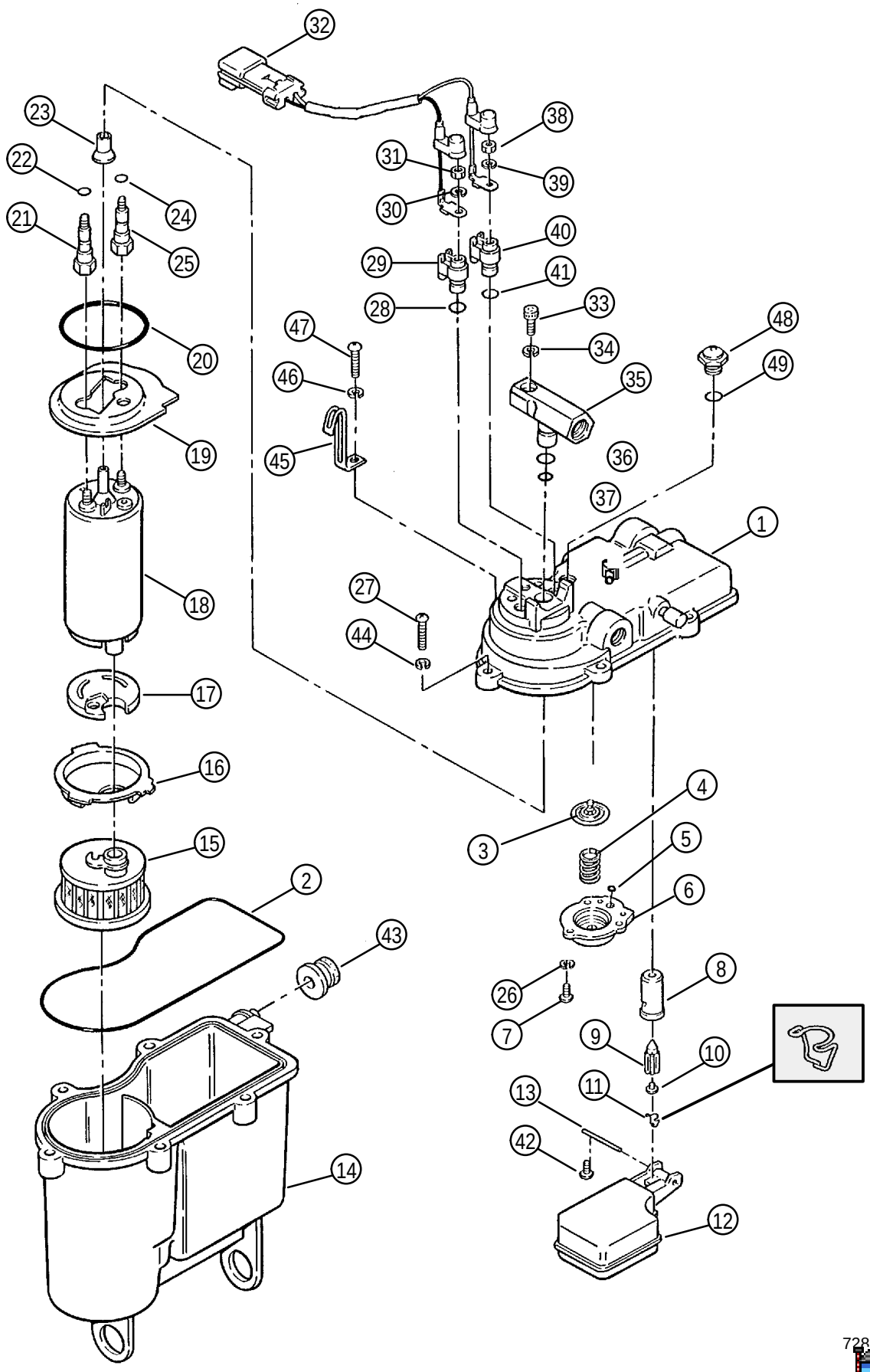
Fuel Delivery Systems

Cool Fuel System Exploded View



1 -Screws (4)
2 -Nut (2)
3 -Bracket
4 -Cover Base
5 -Reference Line To Flame Arrestor
6 -Fitting
7 -Tubing
8 -Fuel Pressure Regulator
9 -Screw (2)
10 -Washer (2)
11 -Washer
12 -Fuel Return Line Fitting
13 -Rubber Bushing (8)
14 -Filter
15 -Outlet Fuel Line To Throttle Body
16 -O-Ring
17 -Fuel Cooler
18 -O-Ring
19 -Drain Plug
20 -Elbow Fitting
21 -O-Rings (4)
22 -Electric Fuel Pump
23 -O-Ring
24 -Fuel Pump Inlet Fitting
25 -Retainer Bracket
26 -Nut (2)
27 -Cover

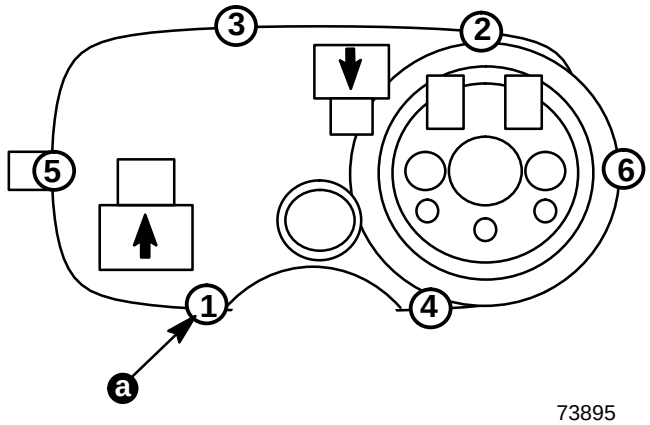
Vapor Separator Tank (VST) Exploded View



72803

1 - Cover
2 - Seal
3 - Spring
4 - Diaphragm
5 - O-ring
6 - Diaphragm Cover
7 - Screw
8 - Valve Seat
9 - Float Valve
10 - Float Valve Pin
11 - Clip
12 - Float
13 - Float Arm Pin
14 - VST Body
15 - Fuel Screen
16 - Plate
17 - Rubber Cushion
18 - Electric Fuel Pump
19 - Plate
20 - O-ring
21 - Adapter
22 - O-ring
23 - Collar
24 - O-ring
25 - Adapter
26 - Lockwasher
27 - Screw
28 - O-ring
29 - Insulator
30 - Lockwasher
31 - Nut
32 - Electrical Connector
33 - Screw
34 - Lockwasher
35 - L-Joint
36 - O-ring
37 - O-ring
38 - Nut
39 - Lockwasher
40 - Insulator
41 - O-ring
42 - Screw
43 - Grommet
44 - Lockwasher
45 - Clip
46 - Lockwasher
47 - Screw
48 - Plug
49 - O-ring

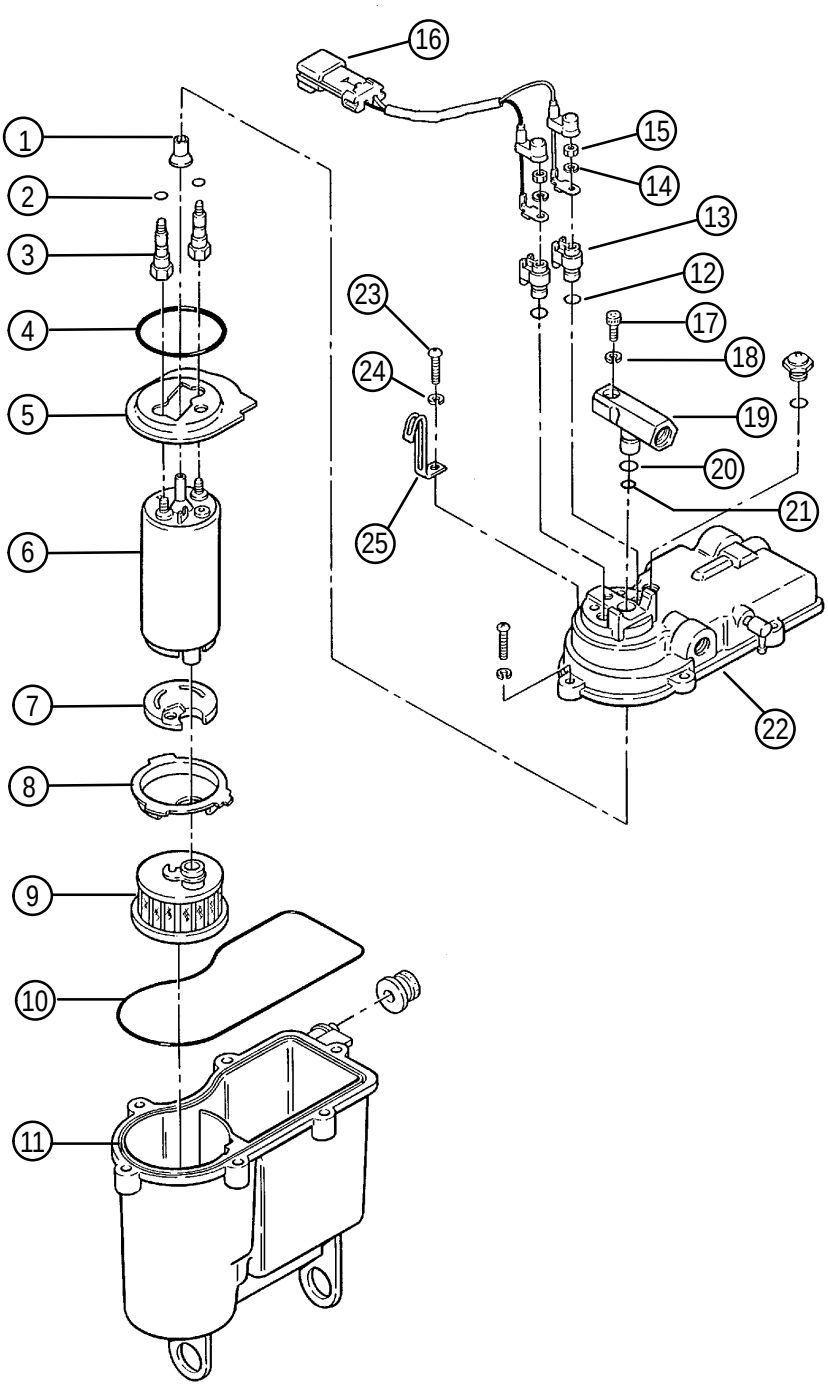
Torque Sequence For VST



73895

a - Tighten Screws Securely

VST Fuel Pump (Exploded View)

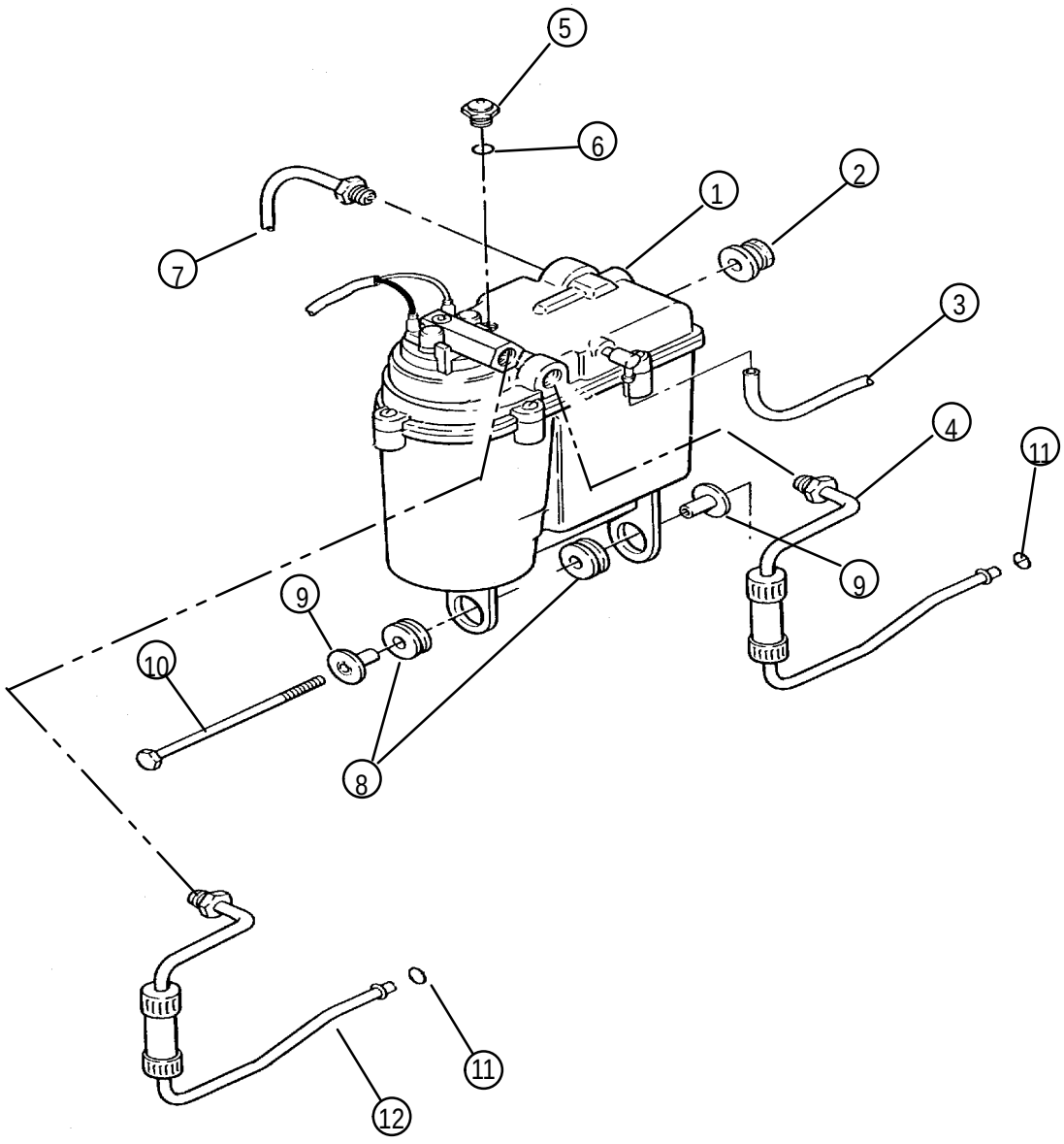


72803

1 - Collar
2 - O-Rings (2)
3 - Adapters (2)
4 - O-Ring
5 - Plate
6 - Electric Fuel Pump
7 - Rubber Cushion
8 - Plate
9 - Fuel Filter
10- Seal
11- Chamber Body
12- O-Rings (2)
13- Insulators (2)
14- Lockwashers (2)
15- Nuts (2)
16- Electrical Connector
17- Screw
18- Spring Washer
19- L-Joint
20- O-Ring
21- O-Ring
22- Cover
23- Screws (6)
24- Lockwashers (6)
25- Clip

Index

VAPOR SEPARATOR TANK (VST)



1 - Vapor Separator Tank (VST)
2 - Grommet
3 - Hose
4 - Fuel Line Return
5 - Plug
6 - O-Ring
7 - Fuel Line VST Supply
8 - Grommet
9 - Bushing
10- Screw
11- O-Ring
12- Fuel Line Supply

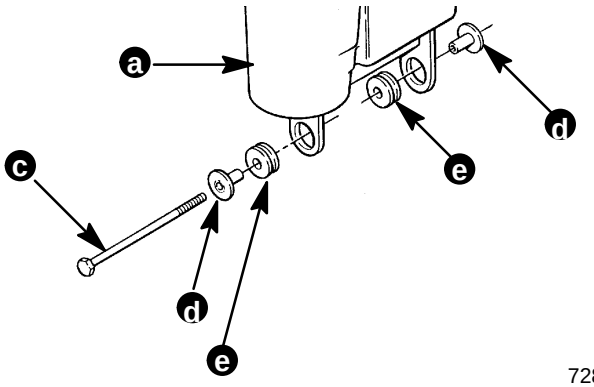
Index

Vapor Separator Tank (VST)

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect fuel pump electrical connector.
2. Label and then disconnect all fuel lines from cover of vapor separator tank.



72804

a - VST
b - Screw
c - Bushing
d - Grommet

3. Remove screw and VST from intake manifold.

INSTALLATION

1. Install VST to intake manifold. Apply Loctite 8831 to threads of attaching screw. Torque bolt to 105 lb. in. (12 N·m).
2. Connect all lines to cover of vapor separator tank. Torque fuel line fittings to 23 lb. ft. (31 N·m).
3. Connect fuel pump electrical connector.
4. With engine off, cycle ignition switch to on,waiting 2 seconds and then off, four times waiting 10 seconds after each key off to prime the fuel system and check for leaks.

NOTE: *If VST is dry, remove the vent screw and fill with fuel.*

REMOVAL - VST FUEL PUMP

1. Disconnect fuel pump electrical connector.
2. Label and then disconnect all lines from cover of vapor separator tank.
3. Remove electrical line from retaining clip.
4. Remove screw from L-joint and pull L-joint from cover.
5. Disconnect fuel pump electrical connectors as follows:
   a. Gently pry each side of connector cover up and over retaining tabs.
   b. Remove connector retaining nuts and remove connectors.
6. Remove cover screws and remove cover and electrical line retaining clip.
7. Carefully slide fuel pump assembly from cover.
8. Remove O-ring, plate, adaptors and collar from fuel pump.
9. Remove screen from fuel pump.
10. Remove plate and rubber cushion.

NOTE: *When replacing fuel pump, make certain to replace with a fuel pump of the identical part number.*

INSTALLATION

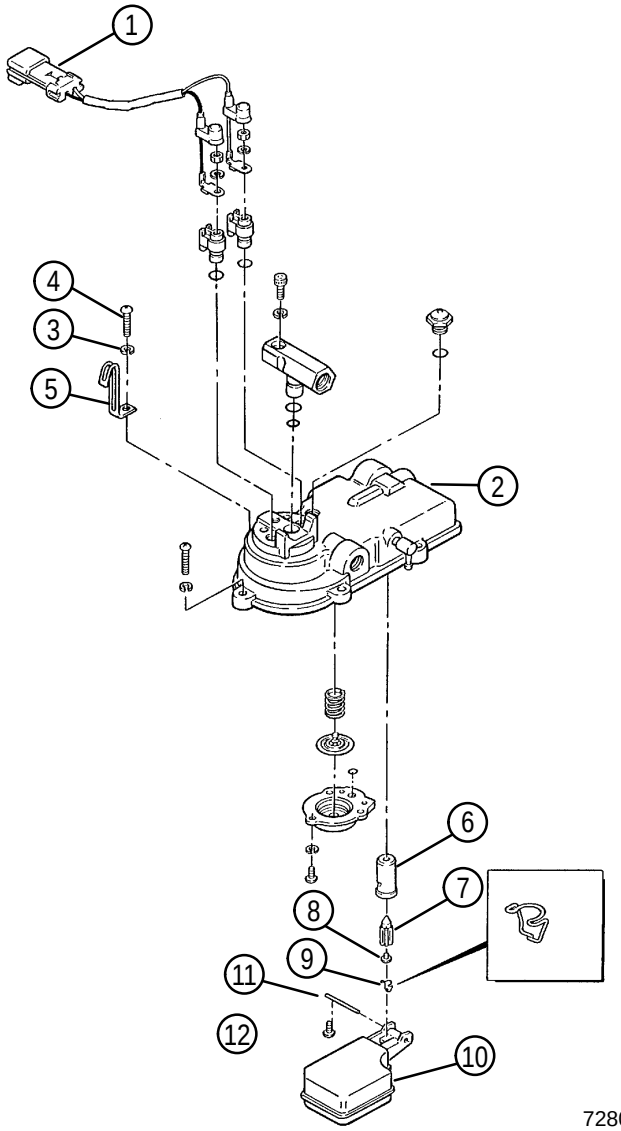
1. Install rubber cushion and plate, making sure to align cutout in plate with pump inlet.
2. Install screen on fuel pump.
3. Install adaptors, collar, plate and new O-ring on fuel pump. Be sure that fuel pump relief valve fits through hole in plate.
4. Slide fuel pump into cover.
5. Apply Loctite Type 8831 to threads of cover screws. Install cover and electrical line retainer clip and tighten cover screws securely.
6. Connect fuel pump electrical connectors. Snap connector covers in place. Secure electrical line in retainer clip.
7. Install L-joint onto cover. Tighten screw securely.
8. Connect all fuel lines to cover of vapor separator tank. Torque fuel line fittings to 23 lb. ft. (31 N·m).
9. Connect fuel pump electrical connector.
10. With engine OFF, cycle ignition switch to ON, wait 2 seconds and then OFF, four times waiting 10 seconds after each key off to prime the fuel system and check for leaks.

NOTE: *If VST is dry, remove the vent screw and fill with fuel.*

Float and Needle Assembly

REMOVAL

1. Disconnect fuel pump electrical connector. (Electric fuel pump removed for visual clarity.)



72803

1 - Electrical Connector
2 - Cover
3 - Lockwashers (6)
4 - Screws (6)
5 - Clip
6 - Valve Seat
7 - Float Valve
8 - Float Valve Pin
9 - Clip
10- Float
11- Float Arm Pin
12- Screw

2. Label and then disconnect all fuel lines from cover of vapor separator tank.
3. Remove electrical line from retaining clip. (some models)
4. Remove cover screws and remove cover and electrical line retainer clip.
5. Remove float arm pin retaining fastener and remove float and needle assembly.
6. Disassemble float and needle assembly; i.e., float valve, float valve pin, clip and float.

CLEANING AND INSPECTION

1. Clean components with carburetor cleaner.

IMPORTANT: Do not soak float or float valve in carburetor cleaner.

2. Inspect float valve seat for wear. Replace if necessary.
3. Inspect float and needle assembly; i.e., float valve, float valve pin, clip and float. Replace parts as necessary.

INSTALLATION

1. Assemble float and needle assembly; i.e., float valve, float valve pin, clip and float.

NOTE: *Float is not adjustable.*

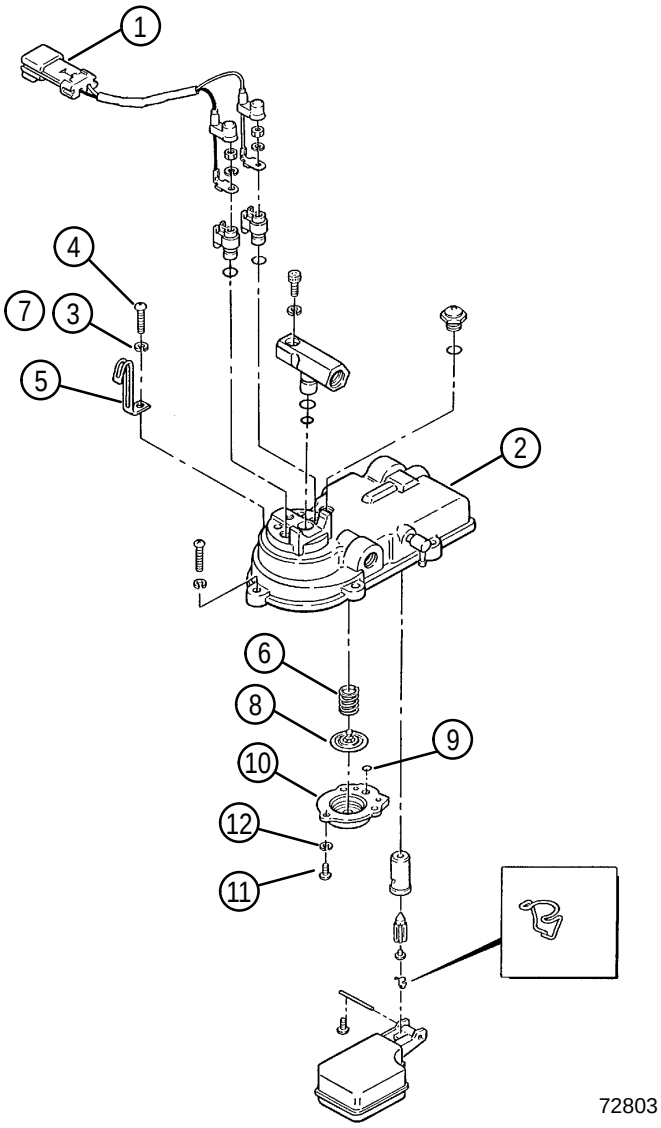
2. Install float and needle assembly and secure float arm pin using fastener.
3. Apply Loctite 8831 to threads of cover screws. Install cover and electrical line retainer clip and tighten cover screws securely.
4. Secure electrical line in retainer clip.
5. Connect all fuel lines to cover of vapor separator tank. Torque fuel line fittings to 23 lb. ft. (31 N·m).
6. Connect fuel pump electrical connector.
7. With engine OFF, cycle ignition switch to ON waiting for 2 seconds, and then OFF, waiting 10 seconds after each key off four times to prime the fuel system and check for leaks.

NOTE: *IF VST is dry. remove vent screw and fill with fuel.*

Diaphragm Assembly

REMOVAL

1. Disconnect fuel pump electrical connector. (Electric fuel pump removed for visual clarity.)



72803

1 - Electrical Connector
2 - Cover
3 - Lockwashers (6)
4 - Screws (6)
5 - Clip
6 - Spring
7 - Diaphragm
8 - O-Ring
9 - Diaphragm Cover
10- O-Ring
11- Screw
12- Lockwasher

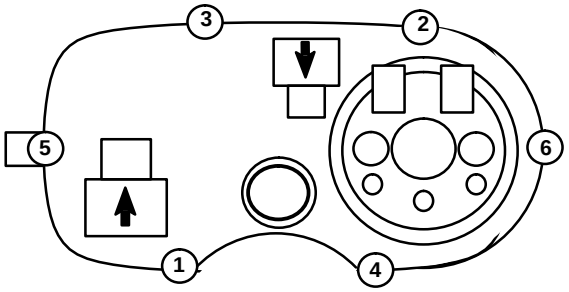
2. Label and then disconnect all fuel lines from cover of vapor separator tank.
3. Remove electrical line from retainer clip.
4. Remove cover screws and remove cover and electrical line retaining clip.
5. Remove float arm pin retaining fastener and remove float and needle assembly.
6. Remove diaphragm cover screws and remove diaphragm cover, O-ring, diaphragm and spring.

CLEANING AND INSPECTION

1. Clean and inspect all parts. Check diaphragm for damage. Replace if necessary.
2. Inspect spring for wear. Replace if necessary.

INSTALLATION

1. Install spring, diaphragm, O-ring and diaphragm cover using diaphragm cover screws. Tighten screws.
2. Install float and needle assembly and secure float arm pin using fastener.
3. Apply Loctite 8831 to threads of cover screws. Install cover and electrical line retainer clip and tighten cover screws securely.



73895

Torque Sequence For VST

4. Secure electrical line in retainer clip.
5. Connect all fuel lines to cover of vapor separator tank. Torque fuel line fittings to 23 lb. ft. (31 N·m).
6. Connect fuel pump electrical connector.
7. With engine OFF, cycle ignition switch to ON,wait for 2 seconds, then OFF, four times, waiting 10 seconds after each key off to prime the fuel system and check for leaks.

Repair Procedures

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S Coast Guard Rules and Regulations to minimize risks of fire and explosion. Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Special Tools

Description	Part Number
Fuel Pressure Gauge	91-168850A1

Lubricants/Sealants/ Adhesives

Description	Part Number
Loctite 8831	92-823089-1
Loctite 262	Obtain Locally
Loctite 242	

Torque Specifications

Fastener Location	Lb. In.	Lb. Ft.	N•m
Flame Arrestor To Throttle Body		50	6
Throttle Body To Adapter		30	40
Adapter To Intake Manifold			
Intake Manifold To Heads		25	34
VST Cover To Body		6	8
Spark Plugs		11	15
VST To Throttle Body		23	31
Sensors And Plugs To Thermostat Housing	Hand Tight Plus 2-1/2 Turns Maximum		
Knock Sensor		14	19
TP Sensor	20		2
IAC Valve		13	18
Distributor Hold-Down Clamp		30	40
MAP Sensor	53		6

Throttle Body Injection System Description

The fuel system consists of a fuel supply, tank, water separating fuel filter, electric fuel pump, pressure regulator, fuel injectors, throttle body and throttle position (TP) sensor.

Fuel is drawn from the boat's fuel supply tank, through a water separating fuel filter and fuel cooler, by a electrical fuel pump.

A pressure regulator located on the fuel cooler maintains a constant fuel pressure. The fuel bled off from the pressure regulator is delivered back to the water separating fuel filter.

The throttle body is the component of the system which supplies the air required for optimum fuel combustion. The throttle body consists of a housing, two injectors, two throttle plates, throttle plate linkage, idle air control (IAC) valve and throttle position (TP) sensor.

Service Precautions

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hoses; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hoses.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in the area while changing fuel filter(s). Wipe up any spilled fuel immediately.

⚠WARNING

Be sure that the engine compartment is well ventilated and that no gasoline vapors are present to avoid the possibility of fire.

⚠WARNING

Make sure no fuel leaks exist before closing engine hatch.

⚠CAUTION

Fuel pressure MUST BE relieved before servicing any component in the fuel system.

⚠CAUTION

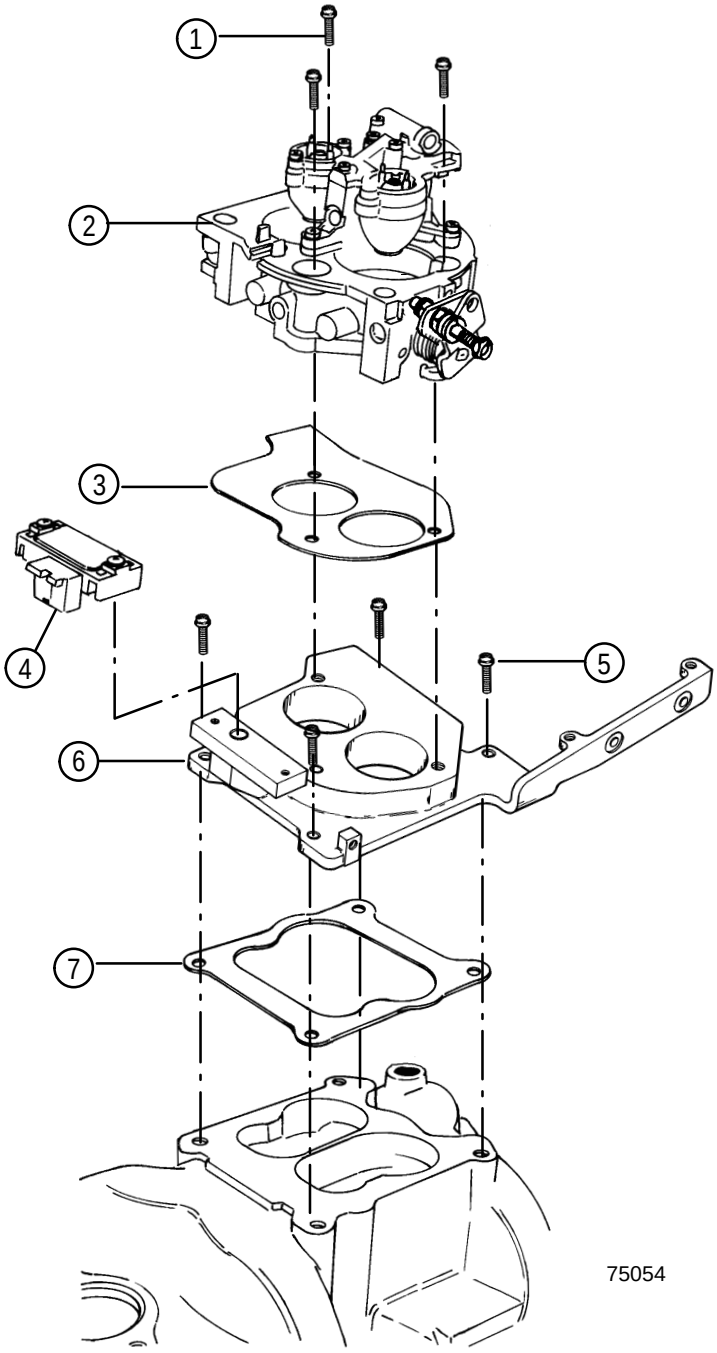
DO NOT operate engine without cooling water being supplied to seawater pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

The following information MUST BE adhered to when working on the fuel system:

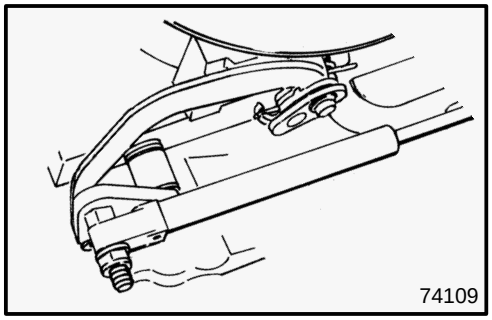
- **Always keep a dry chemical fire extinguisher at the work area.**
- **Always install new O-rings when assembling fuel system parts.**
- **DO NOT replace fuel pipe with fuel hose.**
- **Always relieve system fuel pressure prior to servicing any component in the fuel system.**
- **DO NOT attempt any repair to the fuel system until instructions and illustrations relating to that repair are thoroughly understood.**
- **Observe all Notes and Cautions.**

Throttle Body Exploded Views

Induction System



75054

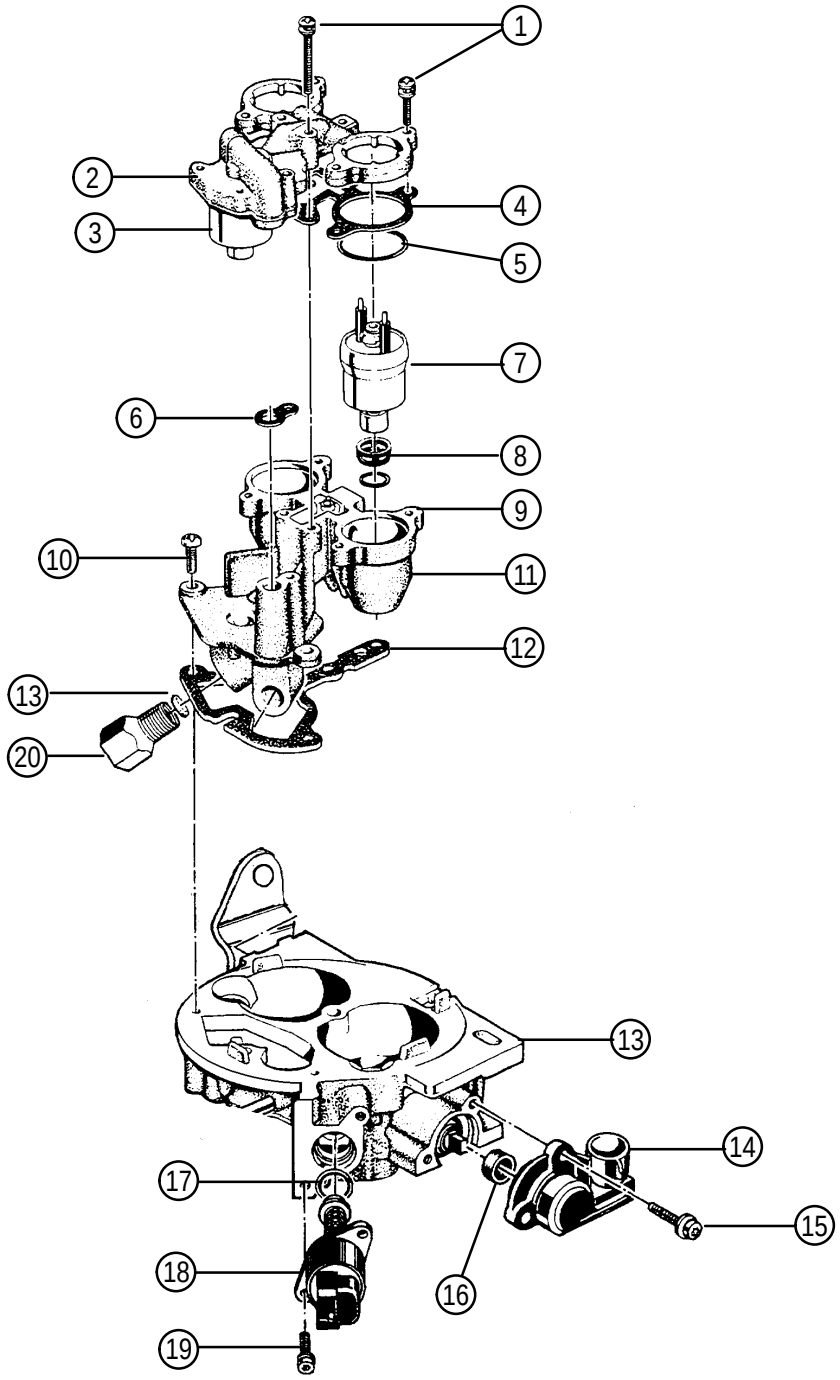


74109

1 - Screws (3)
2 - Throttle Body Unit
3 - Gasket
4 - Throttle Body Adapter Plate
5 - Gasket
6 - Intake Manifold
7 - Screws (2)
8 - Manifold Absolute Pressure (MAP) Sensor
9 - Throttle Linkage

Index

Throttle Body



1 - Cap Screw
2 - Cover Assembly
3 - Fuel Pressure Regulator
4 - Cover Assembly Gasket
5 - Upper O-Ring
6 - Fuel Meter Outlet Gasket
7 - Fuel Injector (2)
8 - Fuel Filter (2)
9 - Lower O-Ring
10- Screw
11- Body
12- Throttle Body To Fuel Meter Body Gasket
13- Throttle Body
14- Throttle Position (TP) Sensor
15- Screws (2)
16- Seal
17- O-Ring
18- Idle Air Control (IAC) Valve
19- Screws (2)
20- Fuel Inlet

Index

Fuel Pressure Relief Procedure

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

1. Disconnect electrical connector from fuel pump.
2. Crank engine for ten seconds (if engine starts allow it to run until it dies) to relieve any fuel pressure in the system.

Fuel Meter Cover Assembly

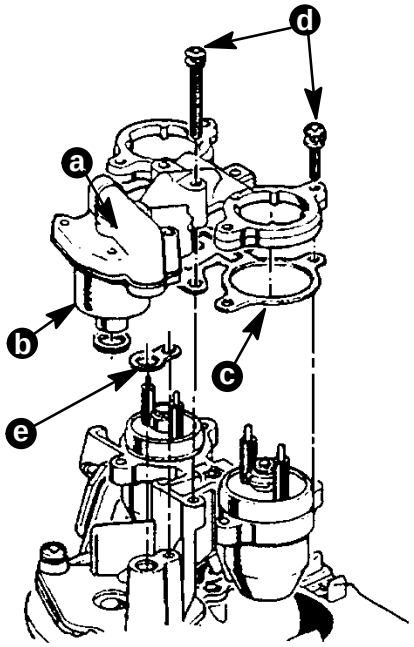
NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

⚠CAUTION

DO NOT remove the four screws securing the pressure regulator to the fuel meter cover. The fuel pressure regulator includes a large spring under heavy compression which, if accidentally released, could cause personal injury.

REMOVAL

1. Remove the flame arrestor from the throttle body.
2. Disconnect electrical connectors to fuel injectors. (Squeeze plastic tabs and pull straight up.)
3. Remove the fuel meter cover screw assemblies.
4. Remove fuel meter cover assembly.



73767

a - Fuel Meter Cover
b - Fuel Damper
c - Gaskets (Regulator Passages)
d - Screws
e - Fuel Meter Outlet Gasket

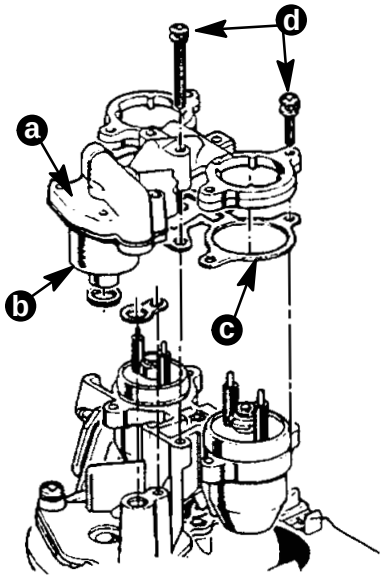
CLEANING AND INSPECTION

IMPORTANT: DO NOT immerse the fuel meter cover (with pressure regulator) in cleaner, as damage to the regulator diaphragm and gasket could occur.

1. Inspect pressure regulator seating area for pitting, nicks, burrs or irregularities. Use a magnifying glass if necessary. If any of the above is present, replace the cover assembly.

INSTALLATION

1. Install new pressure regulator seal, fuel meter outlet passage gasket, and cover gasket.
2. Install fuel meter cover assembly.
3. Install attaching screws, precoated with appropriate locking compound to threads. (Short screws are next to injectors.)
4. Torque screws to 28 lb. in. (3 N·m).
5. Connect electrical connectors to fuel injectors.
6. With engine “OFF,” and ignition “ON,” check for leaks around gasket and fuel line couplings.



73767

a - Fuel Meter Cover
b - Pressure Regulator Assembly
c - Gaskets (Regulator Passages)
d - Screws

Fuel Injectors

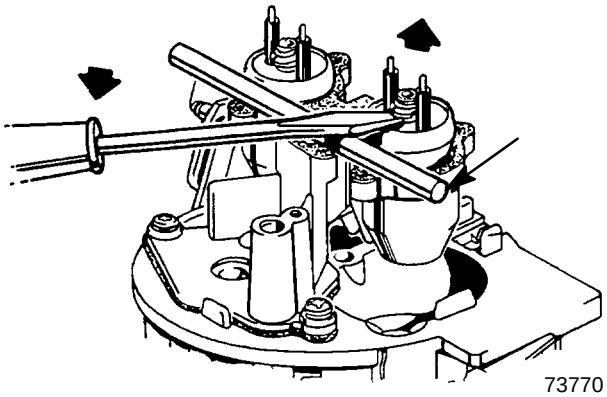
NOTICE
Refer to “Service Precautions,” in “Repair Procedures,” BEFORE proceeding.

REMOVAL

NOTE: *Use care in removing fuel injectors to prevent damage to the electrical connector and nozzle.*

IMPORTANT: The fuel injector is an electrical component. DO NOT soak in any liquid cleaner or solvent, as damage may result.

1. Remove flame arrestor and fuel meter cover as outlined in this section.
2. Using a screwdriver carefully pry up on fuel injector to remove it from the fuel meter body (Use a screwdriver or rod under the the screwdriver when prying up. Leave old gasket in place to prevent damage to fuel meter body).

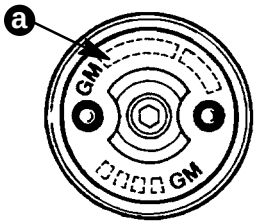


73770

CLEANING AND INSPECTION

Inspect fuel injectors for damage; replace if necessary.

IMPORTANT: When replacing injectors, be certain to replace with the identical part and part number. Other injectors may have the same appearance, yet have a different part number and be calibrated for a different flow rate, and if installed, would cause performance difficulty or damage to the ECM.



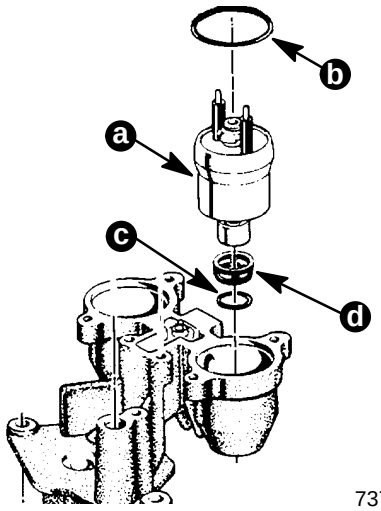
73772

a - Part Indentification Number

Index

INSTALLATION

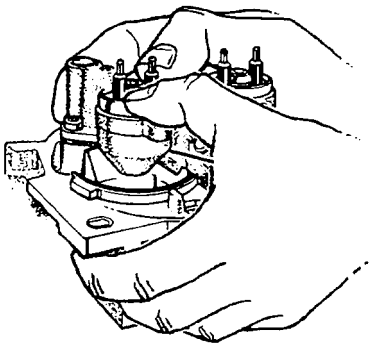
1. Install new lower O-rings on fuel injectors. Lubricate O-rings using a water soap solution.



73766

a - Fuel Injector
b - Upper O-Ring
c - Lower O-Ring
d - Fuel Filter

2. Install upper O-rings in fuel meter body. Lubricate O-rings with water soap solution.
3. Install fuel injectors into the fuel meter body. Align the raised lug on the injector base with the notch in fuel meter cavity.



73771

NOTE: *The electrical terminals of the injectors should be parallel with throttle shaft.*

4. Install gasket and fuel meter cover, torque screws to 28 in. lb. (3.0 N·m) and flame arrestor as outlined in this section.
5. Connect electrical connections to fuel injectors.
6. With engine “OFF,” and ignition “ON,” check for leaks around gasket and fuel line couplings

Throttle Body

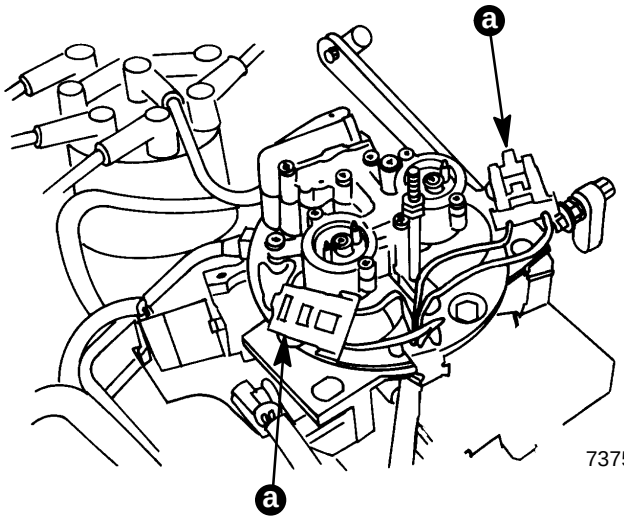
REMOVAL

⚠CAUTION

Ensure that fuel pressure is relieved before removing the fuel inlet and return lines.

IMPORTANT: DO NOT allow the TP sensor, fuel pressure regulator, fuel injectors and IAC valve to come into contact with solvent or cleaner. These components should be removed prior to immersion in solvent.

1. Remove the flame arrestor from the throttle body.
2. Disconnect throttle cable.
3. Disconnect the electrical connections from the TP sensor, IAC and fuel injectors. (Squeeze plastic tabs on injectors and pull straight up).



73750

a - Electrical Connections

4. Remove fuel inlet and outlet lines from throttle body.
5. Remove screws retaining the throttle body to adapter plate.

NOTE: *Place a shop rag over the intake manifold opening to prevent debris from entering intake manifold.*

CLEANING AND INSPECTION

1. Thoroughly clean metal parts of throttle body in a cold immersion type cleaner. Dry with compressed air. Make certain that all passages are free of dirt and burrs.
2. Inspect mating surfaces for damage that could affect gasket sealing.
3. Inspect throttle body for cracks in casting.
4. Inspect throttle plates, linkage, return springs, etc., for damage, wear and foreign material.
5. Check intake manifold plenum for loose parts and foreign material.

INSTALLATION

1. Install fuel injectors and fuel meter body as previously described in this section.
2. Install a new gasket on adapter plate.
3. Install throttle body on adapter plate and torque the screws. 30 ft. lb. (40 N·m).
4. Connect throttle linkage to throttle body.
5. Move throttle from idle to WOT and check that the throttle movement is not binding.
6. Connect the fuel inlet and return lines. Torque to 23 ft. lb. (31 N·m).
7. Connect TP sensor, IAC, and fuel injectors connections.
8. Turn key to on position and check for fuel leaks around the inlet and return line connections.
9. Start engine and check for fuel leaks.

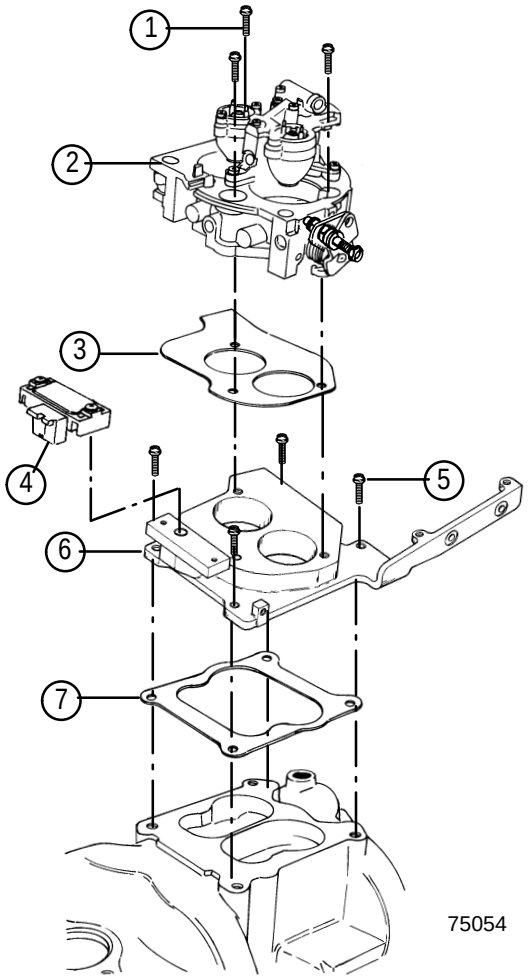
Throttle Body Adapter Plate

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

IMPORTANT: Place a clean shop towel over the intake manifold opening to prevent foreign material from entering the engine.

1. Remove flame arrestor.
2. Remove throttle body refer to Throttle Body Section.
3. Remove screws and the throttle body adapter from the intake manifold.



1 - Screws (3)
2 - Throttle Body Unit
3 - Gasket
4 - Throttle Body Adapter Plate
5 - Gasket
6 - Intake Manifold
7 - Screws (2)
8 - Manifold Absolute Pressure (MAP) Se

Throttle Body Injection Sensor and Module Servicing

Precautions

⚠WARNING

BEFORE attempting to disconnect and remove any module or sensor, check to make sure that the engine ignition system is OFF. Then disconnect the negative (–) battery cable from the terminal. DO NOT reconnect the negative (–) battery cable until the module or sensor removed has been re-installed with secure connections.

IMPORTANT: Modules and sensors are electrical devices easily damaged by contact with liquid cleaners or solvents. Clean with a dry cloth unless specifically directed to do otherwise.

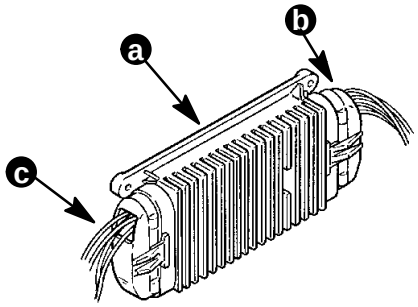
Electronic Control Module (ECM)

IMPORTANT: The ECM is a sensitive electrical device, subject to electrostatic damage. Therefore, take care not to touch connector pins when removing or installing the module.

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect J1 and J2 electrical connectors at engine control module (ECM).



72801

a - ECM
b - J1- Electrical Connector (Front Connector)
c - J2- Electrical Connector (Rear Connector)

2. Remove ECM from electrical bracket.

CLEANING AND INSPECTION

1. Clean the exterior of the ECM with a dry cloth being careful to avoid contact with connector pins.
2. Inspect outer surfaces for any obvious damage
3. Visually inspect electrical pins at both ends of ECM for straightness and corrosion.
4. Visually inspect J1 and J2 connectors on the wiring harness for corrosion and terminals that may have backed of the harness.

NOTE: *The ECM is a sealed electrical component. If a Code 51 check has shown it to be defective, replace the unit with another ECM having the same part number and service number as the original.*

INSTALLATION

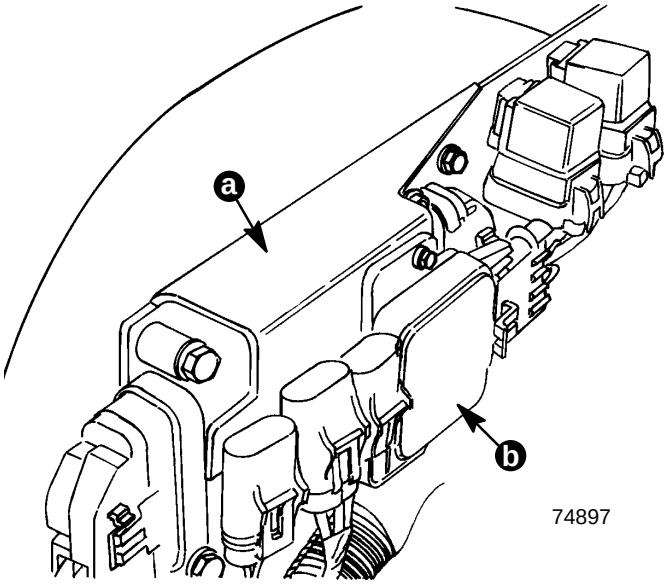
1. Mount new ECM to electrical bracket.
2. Connect J1 and J2 electrical connectors to the ECM.

Knock Sensor (KS) Module

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Remove Knock Sensor from electrical bracket.



a - Electrical Bracket
b - Knock Sensor (KS) Sensor

2. Disconnect electrical connector at Knock Sensor (KS) module.

CLEANING AND INSPECTION

1. Clean the external surfaces of the KS module with a dry cloth.
2. Inspect surfaces of KS module for evidence of damage.

INSTALLATION

1. Connect electrical connector to the Knock Sensor (KS) module.
2. Mount KS module to electrical bracket.

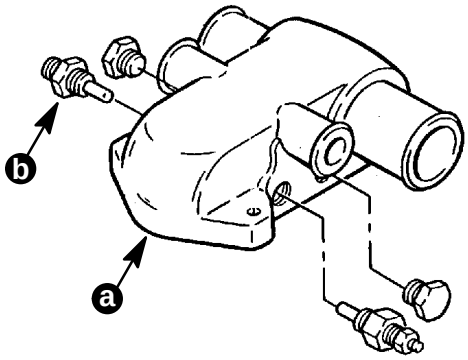
Engine Coolant Temperature (ECT) Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

NOTE: *Handle the ECT carefully as any damage to it will affect operation of the system.*

1. Disconnect electrical connector at Engine Coolant Temperature (ECT) sensor.



a - Thermostat Housing
b - Engine Coolant Temperature (ECT) Sensor

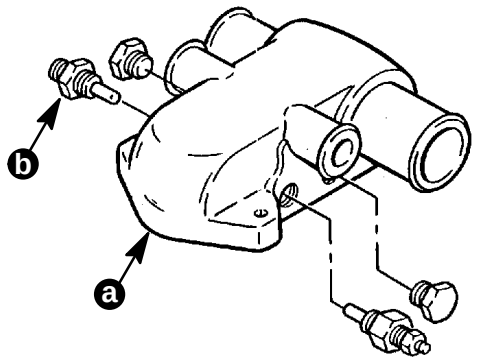
2. Remove ECT from thermostat housing.

CLEANING AND INSPECTION

1. Clean with a dry cloth, removing any excess sealant from the base threads.
2. Look for evidence of any physical damage to base or connector surfaces of the ECT.

INSTALLATION

1. Install ECT in thermostat housing. TIGHTEN HAND TIGHT PLUS 2-1/2 TURNS MAXIMUM.



72799

a - Thermostat Housing
b - Engine Coolant Temperature (ECT) Sensor

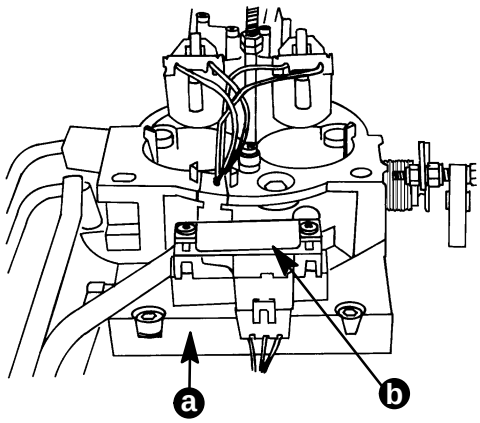
2. Connect electrical connector to ECT.

Manifold Absolute Pressure (MAP) Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector at manifold absolute pressure (MAP) sensor.



73753

a - Throttle Body Adapter Plate
b - Manifold Absolute Pressure (MAP) Sensor

2. Remove MAP sensor from throttle body adapter.

CLEANING AND INSPECTION

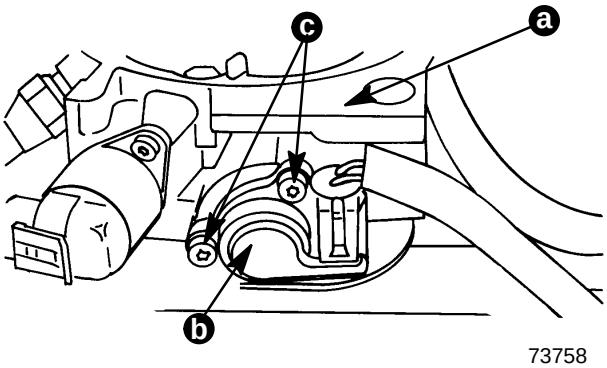
1. Clean off any foreign matter with a dry cloth.
2. Inspect for any obvious signs of physical damage to the sensor.

INSTALLATION

1. Install MAP sensor to throttle body adapter using screws. Torque screws to 44-62 lb. in. (5-7 N·m).
2. Connect electrical connector to MAP sensor.

REMOVAL

1. Disconnect electrical connector at throttle position (TP) sensor.
2. Remove TP sensor from throttle body.



73758

a - Throttle Body
b - Throttle Position (TP) Sensor
c - Screws

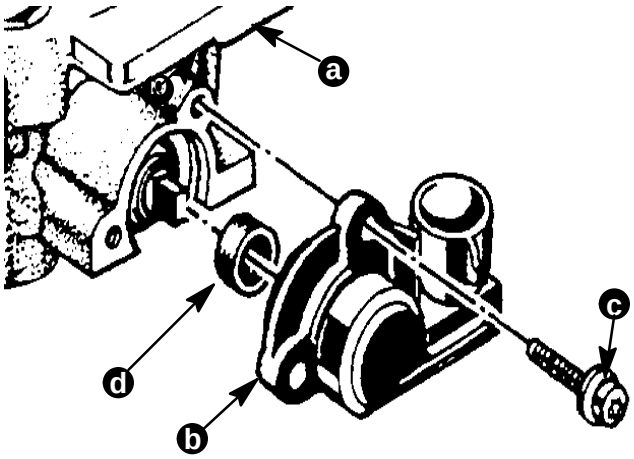
CLEANING AND INSPECTION

1. Clean the surfaces of the TP sensor with a dry cloth.
2. Inspect the TP sensor for signs of wear or damage.

INSTALLATION

IMPORTANT: If the TP sensor is to be replaced with a new unit, be sure to secure it in place with the new screws which are included in the service package.

1. Install TP sensor to throttle body using screws with washers and Loctite 242 applied to threads. Torque screws to 20 lb. in (2 N·m).



73758

a - Throttle Body
b - Throttle Position (TP) Sensor
c - Screws With Lockwashers
d - Seal

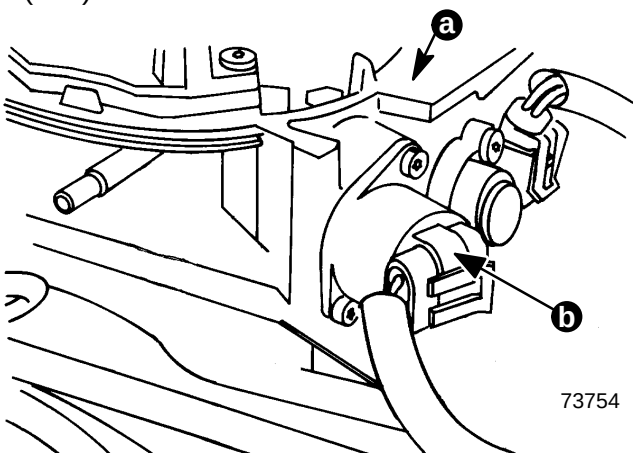
2. Connect electrical connector to TP sensor.
3. Install throttle body, throttle linkage and flame arrestor as outlined in “Throttle Body.”
4. Start engine and check for TP sensor output voltage. It should be approximately .7V at idle and 4.5V at W.O.T.

Idle Air Control (IAC) Valve

NOTICE
Refer to “Service Precautions,” in “Repair Procedures,” BEFORE proceeding.

REMOVAL

1. Remove flame arrestor, throttle cable and throttle body as outlined in “Throttle Body.”
2. Disconnect electrical connector at idle air control (IAC) valve.



73754

a - Throttle Body
b - Idle Air Control (IAC) Valve

3. Remove IAC from throttle body.

CLEANING AND INSPECTION

1. Remove and discard sealing O-ring from IAC valve. Clean sealing surfaces, pintle valve seat, and air passage with a carburetor cleaner to remove carbon deposits, being careful not to push or pull on the IAC valve pintle. Force exerted on the pintle might damage the worm drive. DO NOT use a cleaner that contains the extremely strong solvent methyl ethyl ketone.

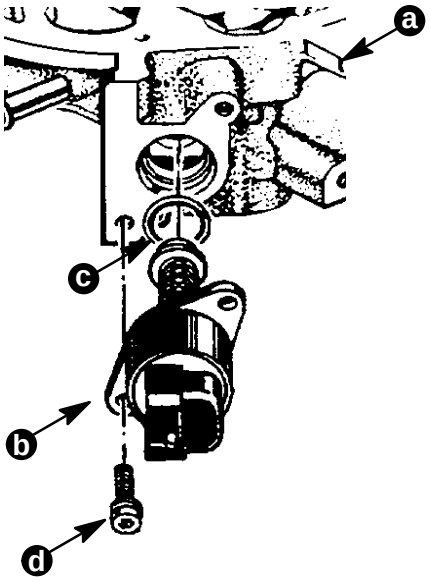
NOTE: *Shiny spots on the pintle, or seat, are normal and do not indicate misalignment or a bent pintle shaft.*

2. Inspect the entire assembly for any obvious physical damage.

INSTALLATION

IMPORTANT: If installing a new IAC valve, be sure to replace it with the correct IAC valve pintle shape and diameter are designed for the specific application.

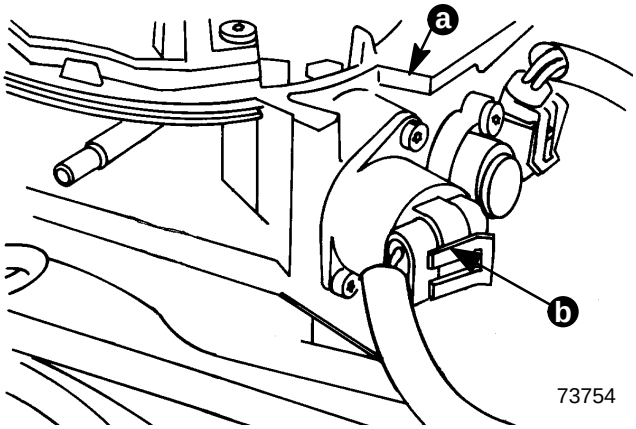
1. Install new O-ring on IAC valve.



73766

a - Throttle Body
b - Idle Air Control (IAC) Valve
c - O-Ring
d - Screws

2. Install IAC valve in throttle body using screws. Torque to 20 lb. in. (2 N·m).
3. Connect electrical connector to IAC valve.



73754

a - Throttle Body
b - Idle Air Control (IAC) Valve

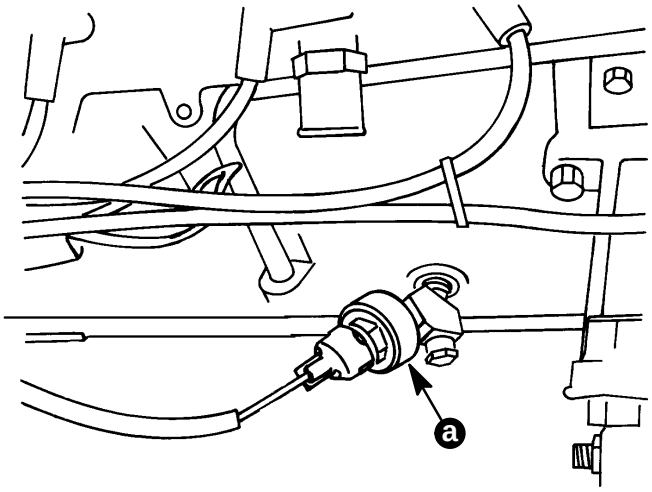
4. Reset IAC valve pintle position after reconnecting negative (–) battery cable.
   a. Turn ignition key ON for ten seconds.
   b. Turn ignition key OFF for ten seconds.
   c. Restart engine and check for proper idle operation.

Knock Sensor

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector at knock sensor located just ahead of starter motor.



73757

a - Knock Sensor

2. Remove knock sensor from engine block.

CLEANING AND INSPECTION

1. Clean knock sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of knock sensor for signs of wear or physical damage.

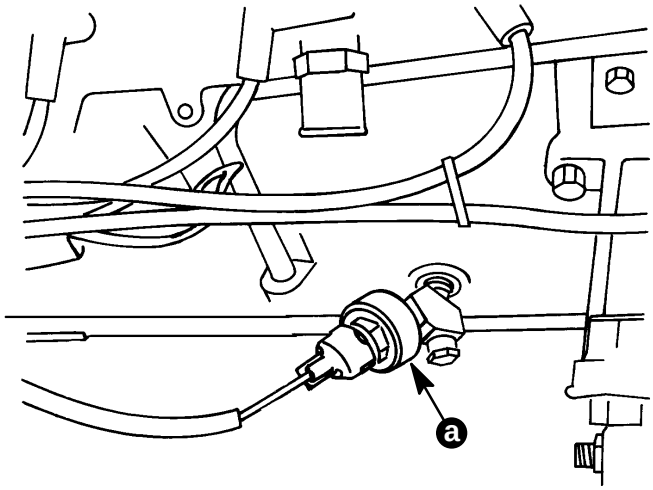
INSTALLATION

IMPORTANT: If installing a new knock sensor, be sure to replace it with an identical part. Knock sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the knock sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. DO NOT use sealer on threads.

IMPORTANT: Ensure that the knock sensor is installed in the upper location on the Y-fitting.

1. Install knock sensor in engine block. Torque to 12-16 lb. ft. (16.3-21.7 N·m).

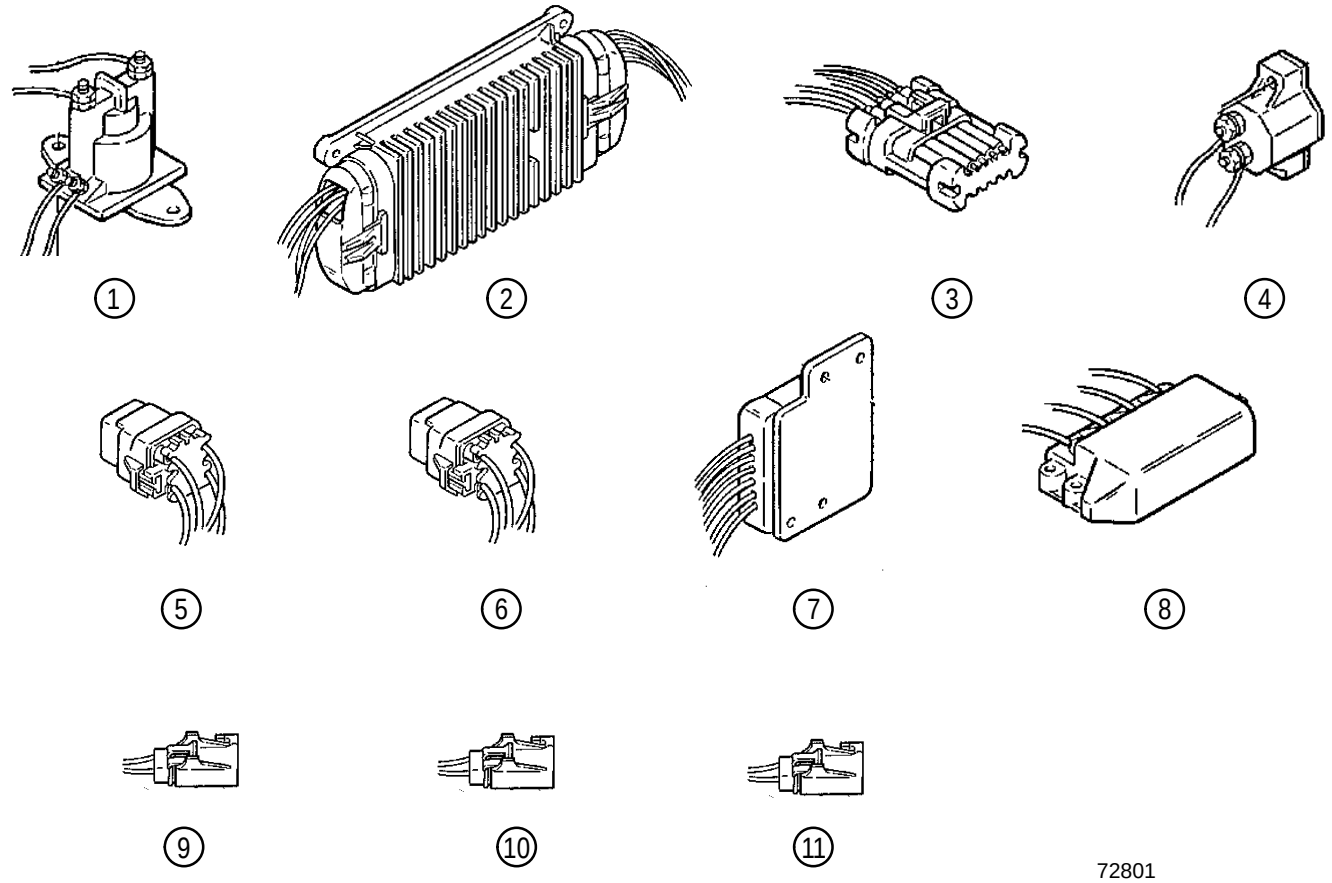


73757

a - Knock Sensor

2. Connect electrical connector to knock sensor.

ELECTRICAL BOX (TYPICAL)



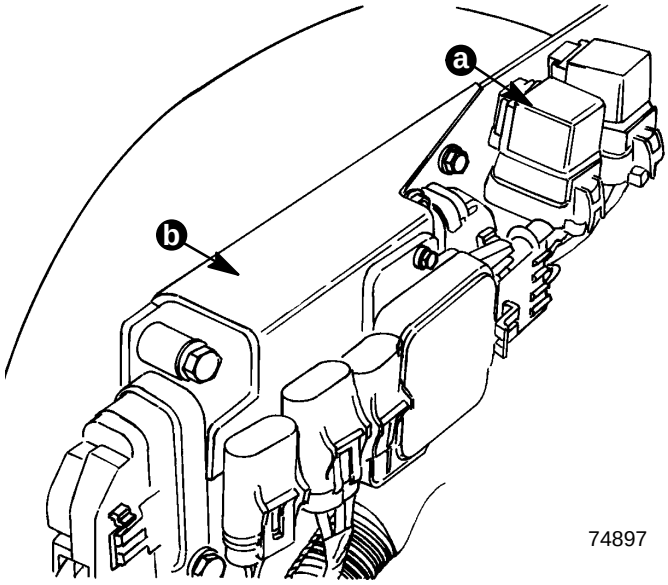
1 - Slave Solenoid
2 - Electronic Control Module (ECM)
3 - Data Link Connector (DLC)
4 - Circuit Breaker
5 - Fuel Pump Relay
6 - Ignition / System Relay
7 - Knock Sensor (KS)
8 - MerCathode
9 - 15 Amp Fuse ECM / Battery
10- 15 Amp Fuse Fuel Pump
11- 10 Amp ECM / Injector

Fuel Pump Relay

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Detach fuel pump relay from bracket.



a - Fuel Pump Relay
b - Bracket

2. Disconnect electrical connector and remove fuel pump relay.

IMPORTANT: The fuel pump relay is an electrical component. DO NOT soak in any liquid cleaner or solvent; damage may result.

INSTALLATION

1. Insert electrical connector into fuel pump relay.
2. Attach fuel pump relay to bracket.

Ignition Control (IC) System Components

Precautions

⚠WARNING

When performing the following procedures, be sure to observe the following precautions to avoid damage to equipment or personal injury:

DO NOT touch or disconnect any ignition system parts while the engine is running.

DO NOT reverse battery cable connections. System is negative (–) ground.

DO NOT disconnect battery cables while engine is running.

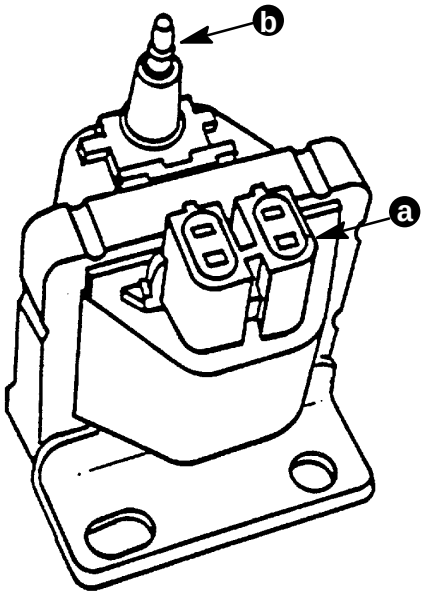
When it is necessary to move any of the wiring, whether to lift wires away from their harnesses or move harnesses to reach components, take care that all wiring is replaced in its original position and all harnesses are routed correctly. Electrical problems can result from wiring or harnesses becoming loose and moving from their original positions or from being re-routed.

Ignition Coil

NOTICE
Refer to "Service Precautions," in "Repair Procedures," BEFORE proceeding.

REMOVAL

1. Disconnect wire harness connectors at coil.



72921

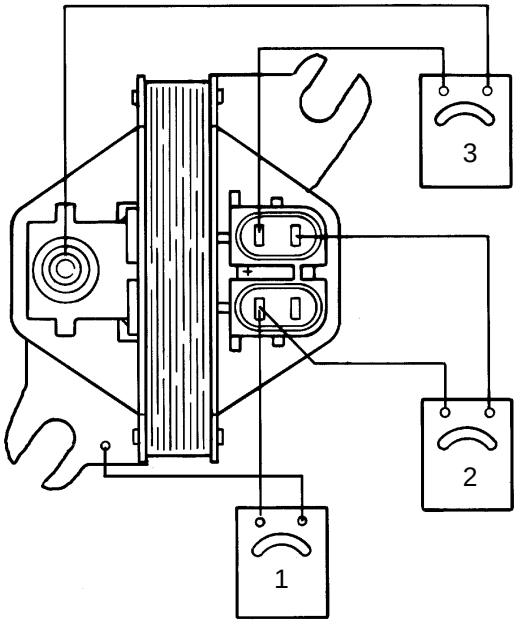
a - Wire Harness Connection
b - High Tension Coil Lead Connection

2. Remove high tension coil lead.
3. Remove coil bracket fasteners and remove coil bracket with coil.

RESISTANCE CHECK

Use an ohmmeter or the ohms function of a DVM for the following check.

1. Connect meter as shown with meter 1 in the figure below.



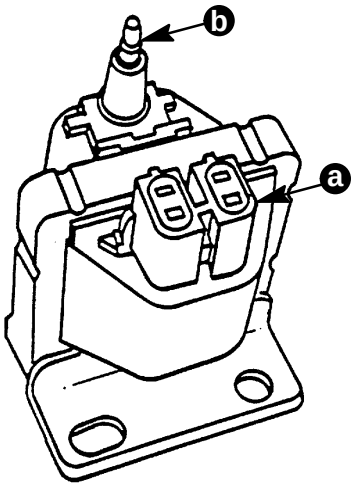
72920

2. Setting the meter to its highest ohms scale, check resistance. The reading should indicate infinite resistance. If it does not, replace the coil.
3. Connect meter as shown with meter 2 in the figure above.
4. Setting the meter to its lowest ohms scale, check resistance. The reading should be very low or zero resistance. If it is not, replace the coil.
5. Connect meter as shown with meter 3 in the figure above.
6. Setting the meter to its highest ohms scale, check resistance. The reading should not indicate infinite resistance. If it does, replace the coil.

INSTALLATION

7. Install coil bracket with coil to engine bracket using fasteners.

8. Connect high tension coil lead.



72921

a - Wire Harness Connection
b - High Tension Coil Lead Connection

9. Connect wire harness connectors.

IGNITION TIMING SET PROCEDURE

The engine must be at **NORMAL OPERATING TEMPERATURE** for this adjustment. Two items of test equipment are required: an inductive pickup timing light and either a Scan Tool, Diagnostic Code Tool, or MerCruiser Special Timing Tool (91-805747A1).

1. Connect timing light to number 1 ignition wire.
2. Connect the appropriate tool (as listed above) to the DLC connector of the wiring harness.
3. Manually adjust the engine throttle to **1800 RPM ± 200.**
4. **If Not Using MerCruiser Timing Tool:** With engine running, set the scan tool or Diagnostic Code Tool to service mode.
5. Shine the timing light at the timing mark indicator located on the timing chain cover.

NOTE: *If adjustment is needed, loosen the distributor hold-down bolt and rotate the distributor clockwise or counterclockwise to adjust the timing. Then repeat the timing light check until the specification (8 degrees BTDC) is met.*

6. Torque distributor hold-down bolt to 30 lb. ft. (40 N·m).
7. Set Scan Tool or Diagnostic Code Tool to normal mode. If using the MerCruiser Special Timing Tool, disconnect it from DLC connector.
8. Manually close throttle to bring engine down to idle state.

Spark Plug Replacement

SPARK PLUG WIRING AND BOOT PRECAUTIONS

1. **Twist boots one-half turn before removing.**
2. **When removing boot, DO NOT use pliers or other sharp tools which might tear the boot.**
3. **DO NOT force any object between the wire and the boot or through the silicone jacket of the wiring.**
4. **DO NOT pull on the wires to remove the boot. Pull on the boot or use a tool designed for this purpose.**
5. **Special care must be used when installing spark plug boots to ensure that the metal terminal within the boot is fully seated on the spark plug terminal and that the boot has not moved on the wire. If boot-to-wire movement has occurred, the boot will give a fast visual impression of being seated. To make sure that boots have been properly installed, push sideways on them. If they have been correctly installed, the boots will fit tightly with only a slight looseness. If the terminal has not been firmly seated on the spark plug, only the resistance of the rubber boot will be felt when pushed sideways.**

REMOVAL

1. Disconnect spark plug wires from spark plugs.
2. Remove spark plugs.

CLEANING AND INSPECTION

1. Clean spark plugs and spark plug wires with a dry cloth.
2. Check each spark plug for wear and gap width per MerCruiser specifications. Replace any which fail to meet the standards.
3. Check spark plug wires for damage to insulation, boots and connectors. Replace if necessary.

Index

INSTALLATION

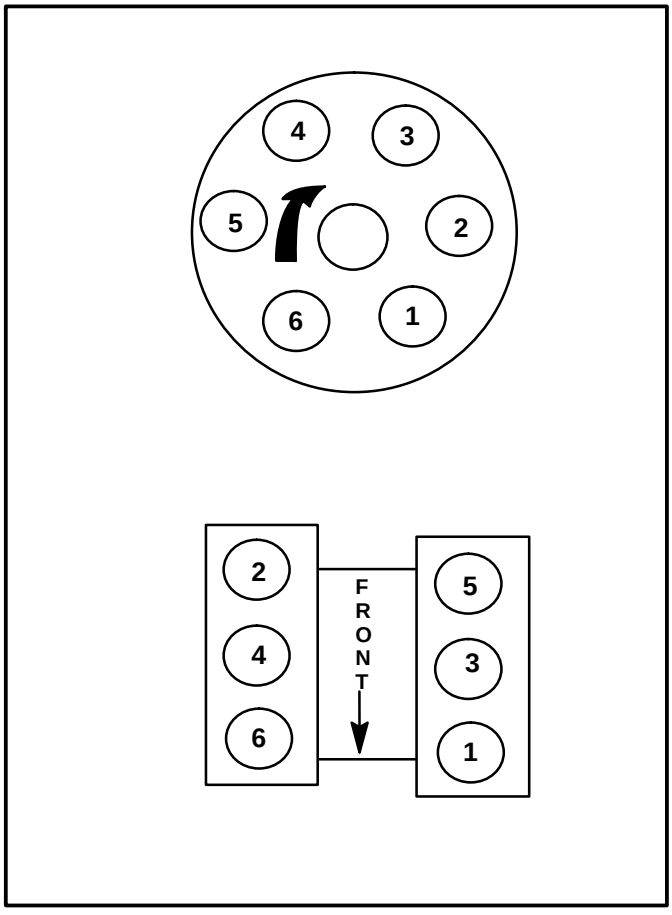
1. Install spark plugs. Torque to 11 lb. ft. (15 N·m).
2. Connect spark plug wires to their respective spark plug.

IMPORTANT: Wire routing must be kept intact during service and followed exactly when wires have been disconnected or when wire replacement is necessary. Failure to route wires properly can lead to radio frequency interference, cross firing of the plugs, and/or shorting of leads to ground.

NOTE: *When replacing spark plug wires, it is good practice to replace one wire at a time to reduce the risk of error.*

REMOVAL AND INSTALLATION

1. Disconnect one spark plug wire at spark plug and distributor.
2. Connect new spark plug wire at spark plug and distributor.
3. Continue steps 1 and 2 until all spark wires have been replaced.



Engine Rotation and Firing Order

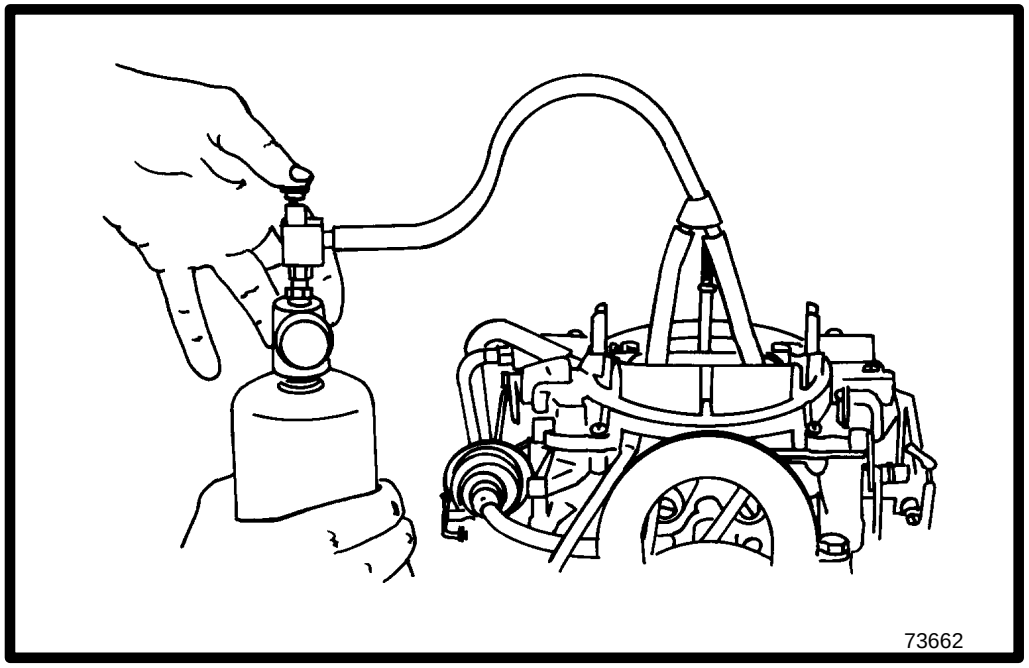
Index

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

FUEL SYSTEM



5

E

BSO / SAV EMISSION FUEL SYSTEM

Index

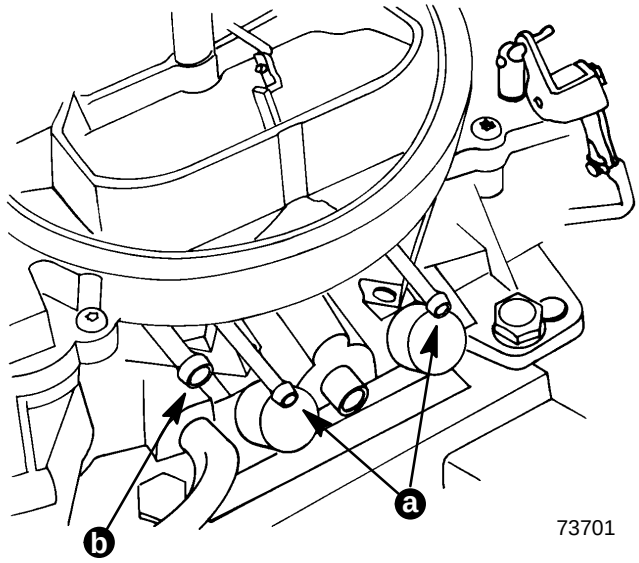
Table of Contents

	Page
Identification	5E-1
Replacement Parts Warning	5E-1
Torque Specifications	5E-1
Special Tools	5E-1
Carburetor Specifications	5E-2
Carburetor Adjustment Specifications	5E-2
Engine Specifications	5E-2
Description	5E-3
Special Notes	5E-3
Carburetor Top Cover	5E-3
Sealed Idle Mixture Screws	5E-3
Metering Assembly	5E-4
Precautions	5E-5
Maintenance	5E-6
Flame Arrestor	5E-6
Fuel Filter	5E-6
Positive Crankcase Ventilation (PCV)	5E-6
Troubleshooting	5E-7
Checking Ported Vacuum Switch and Carburetor Vacuum Circuit for Correct Operation	5E-7
Service Procedures	5E-8
Checking Positive Crankcase Ventilation (PCV) Valve	5E-8
Removing Seals From Idle Mixture Screws	5E-9
Installing New Seals	5E-9
Carburetor Installation	5E-10
Ported Vacuum Switch Installation	5E-10
Emissions System Connections	5E-11
Propane Assisted Idle Set Procedure	5E-12
Test Equipment	5E-14
Emissions Testing	5E-14

Index

Identification

The Bodensee Emissions version of the Weber WFB carburetor has vacuum fittings on the front side.



a - Vacuum Fittings

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion. Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Torque Specifications

Description	lb. in.	lb. ft.	N·m
Carburetor to Manifold	132		15
Fuel Line to Carburetor		18	24

Special Tools

Mercury Marine Special Tools	
Description	**Part Number**
Universal Carburetor Gauge	91-36392
Tachometer	91-59339

Other Special Tools	
Description	**Part Number**
Universal Carburetor Stand	Obtain Locally
TORX® Screwdrivers (15,20&25)	
Propane Bottle [14 oz. (400 grams)]	
Propane Enrichment Kit (Various Suppliers)	(1) J26911 (2) YA7148 (3) 7148
Ported Vacuum Switch (PVS) Socket Wrench (Various Suppliers)	(1) No PN (2) S9842A (3) 7267

Special Tool Suppliers:
(1) Kent-Moore Part Number
(2) Snap-On Part Number
(3) OTC Part Number

NOTE: *Weber carburetors will have a "star" shaped socket in the head of some screws. A TORX® screwdriver must be used on this type of screw. The sizes used are numbers 15, 20 and 25.*

Carburetor Specifications

Units of Measurements In.(mm)

Engine Model	Carb Type	Mercury Number (Manufacturer Number)	Primary Jet Size	Second-ary Jet Size	Metering Rod Number	Meter-ing Rod Spring Color
MCM 4.3LX	Weber WFB	3310-806120 (9662)	.086	.080	16-656457	Natural

Carburetor Adjustment Specifications

Make And Model	Weber WFB
Float Level	1-9/32 (33)
Float Drop	2 In. (51)
Pump Rod Hole Location	Number 3 from end (Hole closest to lever pivot point)
Accelerator Pump	7/16 (11) (Note 1)
Choke Pull Off	1/8 (3.5)
Choke Coil Rod	Top of Rod Even with Bottom of Lever Hole (Note 2)

Note: 1. Measured from top of Carburetor to bottom of “S”- Link

Note: 2. Remove choke rod from lever hole. choke held closed and choke rod is pushed down with top edge of rod even with bottom edge of hole.

Engine Specifications

Model	**4.3LX Alpha**
Thermostat	160°F (71°C)
Ignition Timing	10° BTDC
Idle Speed in Neutral	775 RPM
Propane Idle Speed (See Procedure)	850 RPM

Description

The Bodensee Emissions system is designed to lower exhaust emissions to meet regulations on the “Bodensee”. It consists of the following items: a Positive Crankcase Ventilation (PCV) circuit, a Ported Vacuum Switch (PVS) circuit, a higher temperature thermostat [160°F (71°C)], and a specially designed Weber WFB carburetor.

Weber WFB carburetor is unique in design, as the main body and flange are cast as a one piece unit. This, along with the bowl cover, make up the two piece construction which is made of light, durable aluminum to dissipate heat.

There are two separate float circuits. Each float circuit supplies fuel to a primary low speed circuit and a primary and secondary high speed circuit. The bowls are vented to the inside of the air horn. A connecting vent passage effects a balance of the air pressure between the two bowls.

The float needle valves are installed at an angle to provide the best possible seating action on the needles. This provides better needle response to float movement, also.

The PVS circuit is used in conjunction with the idle circuit. When the engine is cold, the PVS circuit is closed. This shuts off a metered air-bleed to the idle circuit, to maintain a rich idle circuit for warm-up. Once the engine warms up [approximately 128°F (54°C)], the PVS opens, allowing a metered amount of air to be mixed into the idle circuit. This leans the idle circuit to the proper operating air-fuel ratio.

The high speed circuits use staged step-up rods in the main metering jets to control the amount of fuel admitted to the nozzles. The position of the step-up rod is controlled by manifold vacuum applied to the vacuum piston.

A primary air bleed located in the venturi cluster prevents a rich condition or bog as the high speed circuit is reactivated after deceleration.

Small “L” shaped metal tabs, called “distribution tab(s),” are attached to some venturi clusters and protrude into the air stream at the proper location to aid distribution of fuel on selected applications.

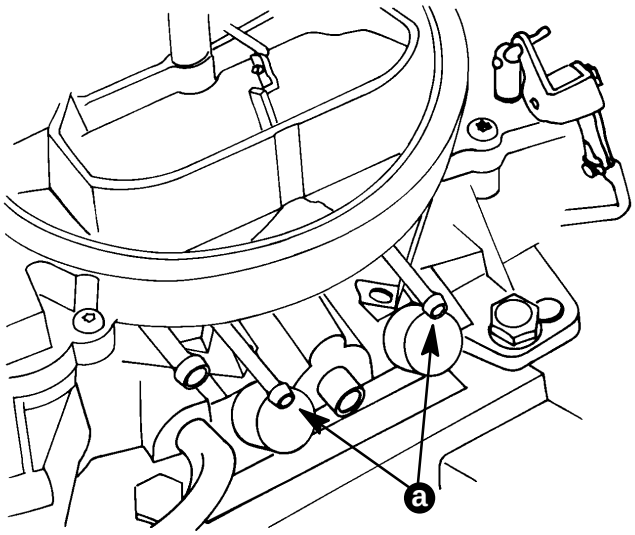
The PCV circuit ventilates crankcase vapors (unburned gases) back into the intake manifold to be burned again.

Special Notes

IMPORTANT: Disassembly and repair of the Bodensee Emissions carburetor is basically the same as the other Weber WFB carburetors. There are some internal and external differences that are noted following:

Carburetor Top Cover

The carburetor top cover (air-horn) has vacuum fittings for connection to the “Ported Vacuum Switch” (PVS).

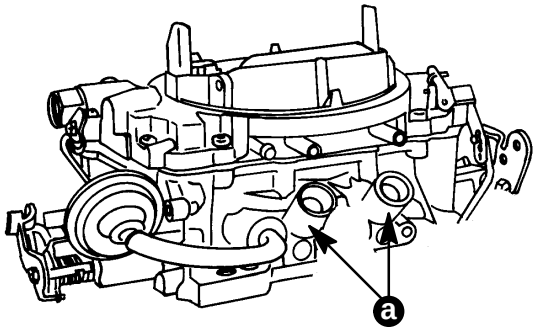


73701

a - Vacuum Fittings

Sealed Idle Mixture Screws

The idle mixture screws have seals that prevent tampering with the idle mixture after the mixture has been properly adjusted.



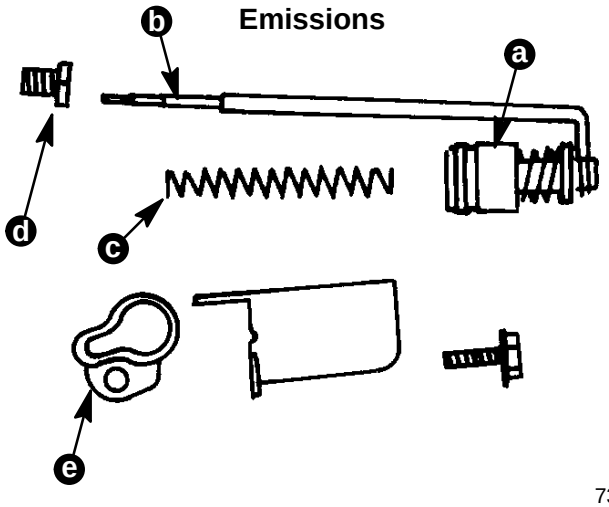
71798

a - Screw Seals

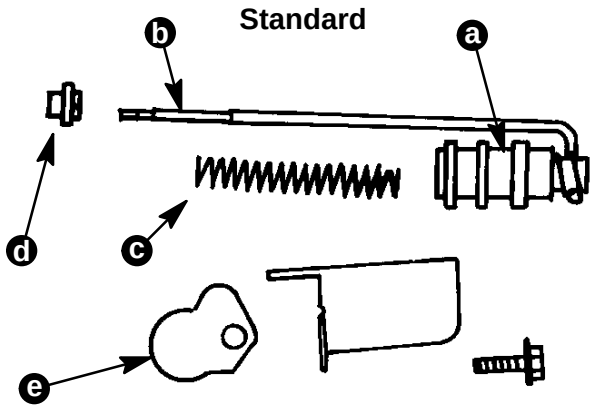
Index

Metering Assembly

The metering rod assemblies are different in the following ways:



73732

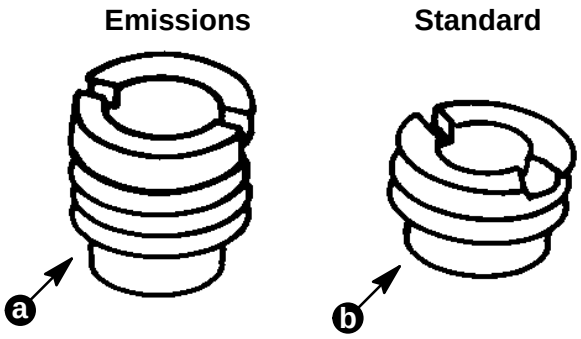


73729

a - Piston
b - Metering Rod
c - Spring
d - Jet
e - Piston Cover

METERING JETS

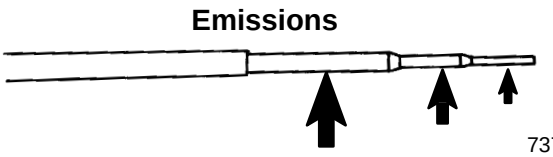
The metering jets in this carburetor are taller than the jets in a standard carburetor.



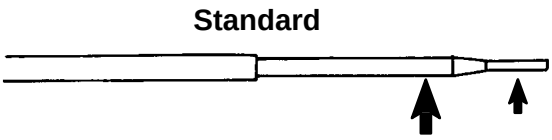
73728

a - Jets For 3 Step Metering Rod
b - Jets For 2 Step Metering Rod

METERING ROD HAS “THREE STEPS” -VS- TWO

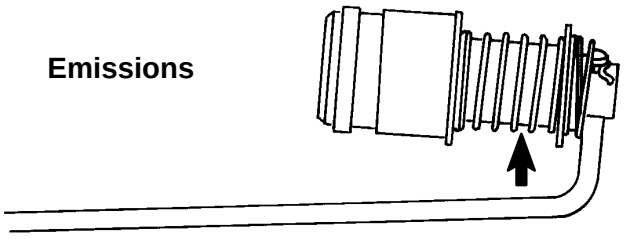


73726

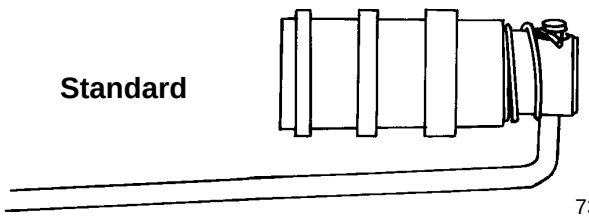


73724

PISTON SHAPE IS DIFFERENT AND HAS A SECOND SPRING

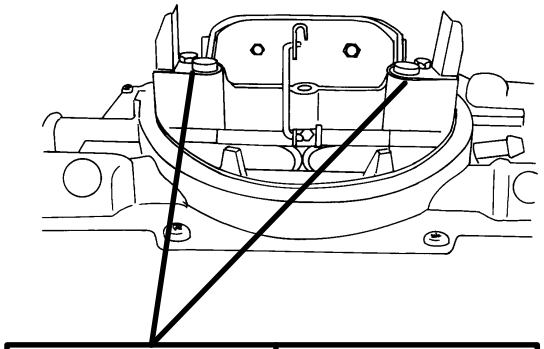


73730

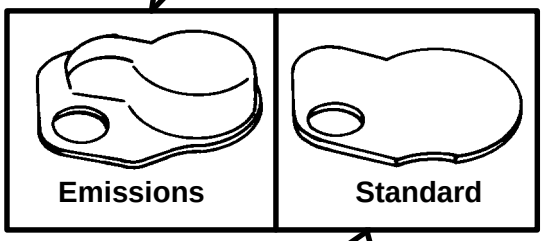


73727

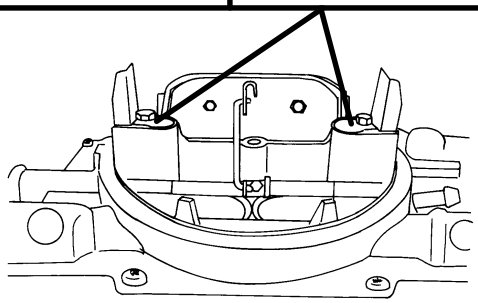
PISTON ASSEMBLY COVER IS HIGHER



73735

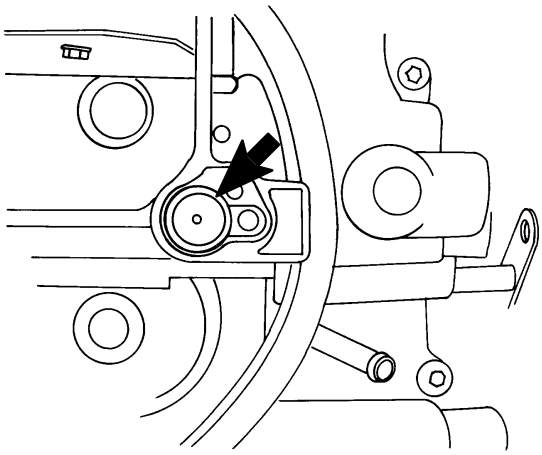


73725



73736

PISTON BORE HAS A STEP ON EMISSIONS MODEL



73737

Precautions

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose: gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING

Be careful when changing fuel system components: gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠WARNING

Make sure no fuel leaks exist, before closing engine hatch.

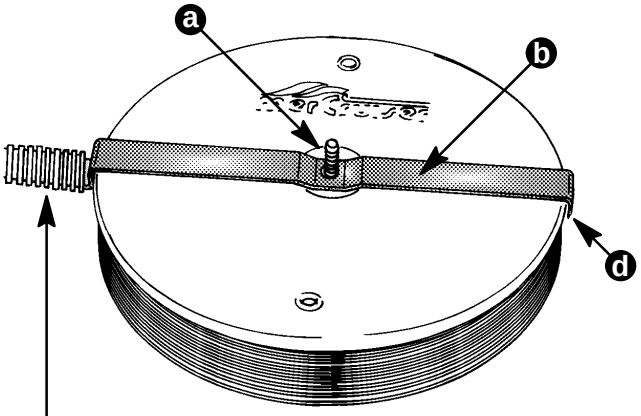
⚠CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing or water pickup inlet, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

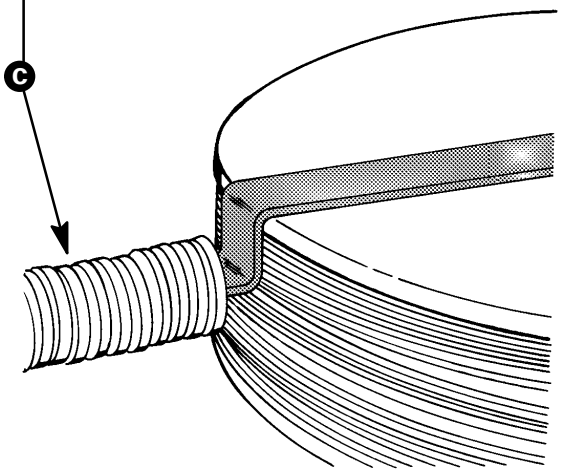
Maintenance

Flame Arrestor

Maintenance for the flame arrestor is the same as standard engine (See the Weber WFB carburetor section of the appropriate MerCruiser Service Manual). The only difference in the flame arrestor on an engine with the Bodensee Emissions system is in the vent hose bracket. This bracket has a fitting on one side only.



71798



71797

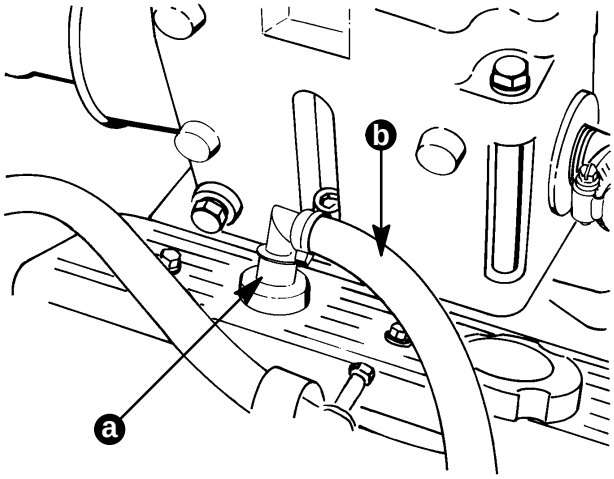
a - Stud
b - Vent Hose Bracket
c - Vent Hose To Starboard Valve Cover
d - NO VENT HOSE ON THIS SIDE

Fuel Filter

Maintenance for fuel inlet filters is the same as standard engine (See the Weber WFB carburetor section of the appropriate MerCruiser Service Manual).

Positive Crankcase Ventilation (PCV)

The Positive Crankcase Ventilation (PCV) valve should be replaced once a year.



71925

a - PCV Valve
b - Hose

Index

Troubleshooting

NOTE: *Review the "Description" section of this manual for an understanding of system operation, before troubleshooting the carburetor. Do not assume that a problem exists inside the carburetor without first eliminating other engine system components as potential problem areas. Be sure to check the following items:*

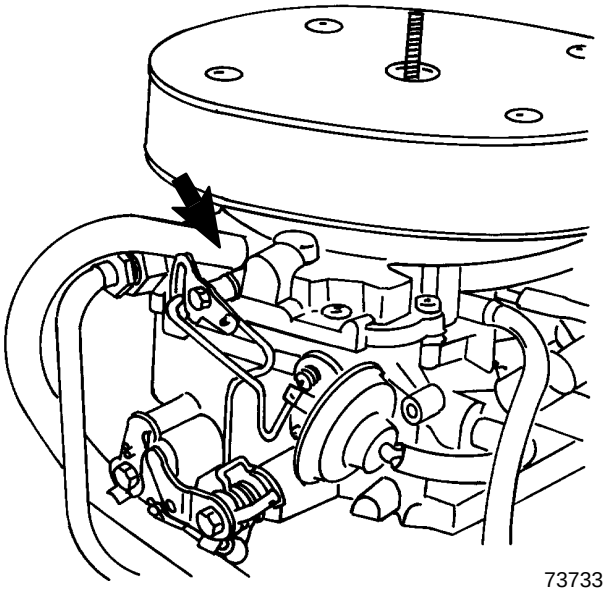
- Engine operating temperature (Proper Thermostat - See "Engine Specification Chart").
- Correct ignition timing (See "Engine Specification Chart").
- Cylinder compression.
- Ported Vacuum Switch (PVS) functioning properly.

Use the following procedure to check for a faulty Ported Vacuum Switch (PVS):

Checking Ported Vacuum Switch and Carburetor Vacuum Circuit for Correct Operation

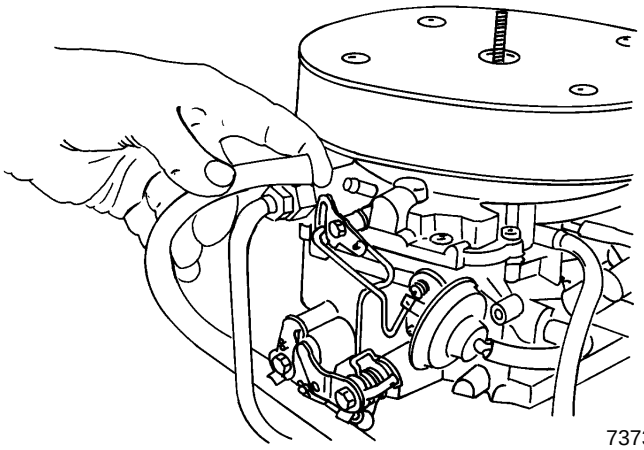
NOTE: *The engine must be cold before performing the first 4 steps.*

1. Start engine. Disconnect the hose from the carburetor at the location shown.



73733

2. Plug the hose with your finger. You should not feel vacuum on the hose at this time.

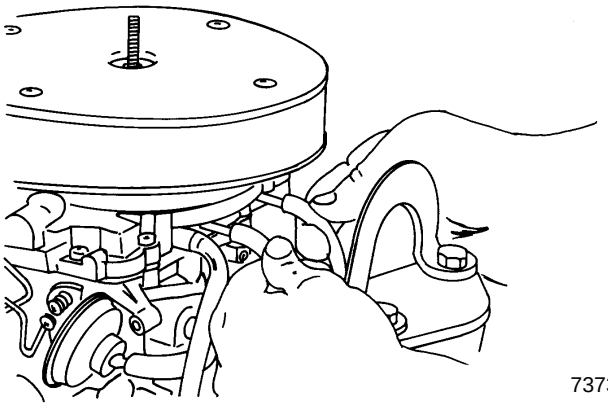


73734

3. Allow engine to run and warm up to normal operating temperature. Disconnect the hose again and check for vacuum. If PVS is functioning properly, there should be vacuum present at this time. If vacuum is not present, check to ensure that hoses are properly connected and are not cracked or plugged. Then, proceed to check the carburetor vacuum circuit.
4. Reconnect rear hose to carburetor.

NOTE: *The engine must be warm before performing the next step.*

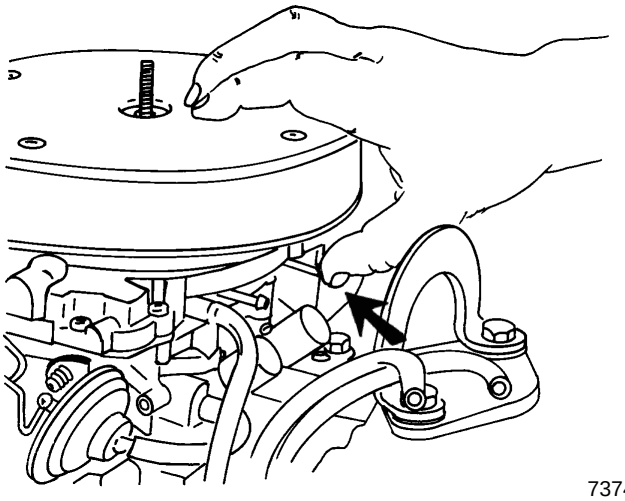
5. Start engine and allow it to reach normal operating temperature.
6. Disconnect the two hoses on the front of carburetor.



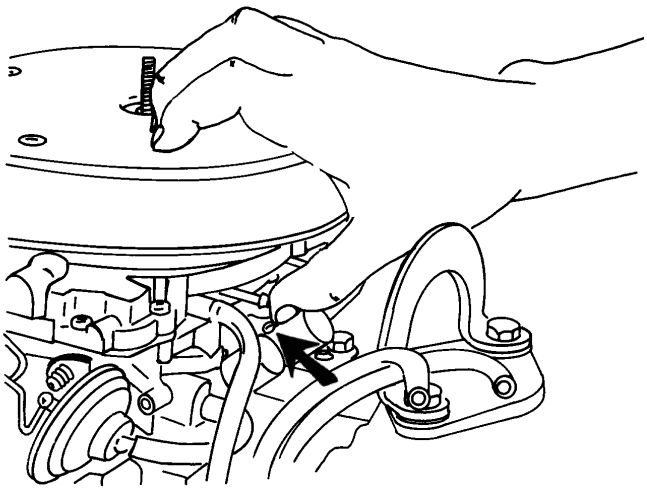
73738

IMPORTANT: Ensure that engine is running at 775 RPM or below. This ensures that the carburetor is not running on the "Off-Idle" circuit.

7. Connect a tachometer to the engine.
8. Plug the vacuum ports on the front of the carburetor. Be sure to only plug one port at a time. When vacuum port is covered, the engine RPM should increase. Repeat test on the other port. If vacuum is not present, a vacuum port may be plugged. Clean vacuum ports and repeat the entire test.



73740



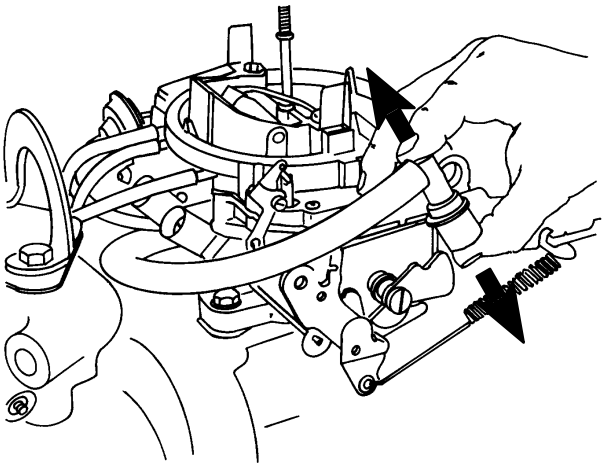
73739

9. When test is complete and PVS is determined to be functioning properly, reconnect all hoses in vacuum circuit.

Service Procedures

Checking Positive Crankcase Ventilation (PCV) Valve

1. Start engine and allow it to reach normal operating temperature.
2. Remove PCV valve from valve cover. Plug the opening with your finger. A vacuum should be felt.
3. Stop the engine.
4. Shake the valve to ensure that the internal components are free to move.



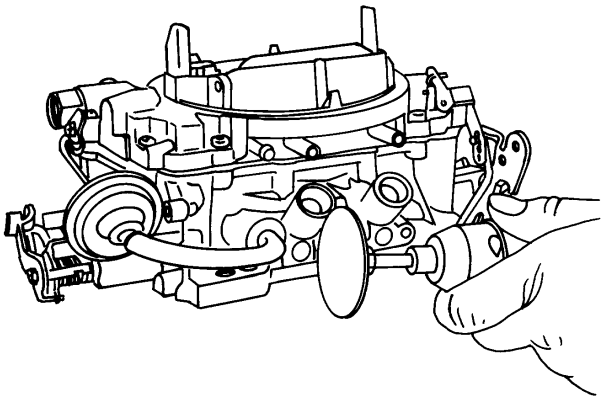
73743

Removing Seals From Idle Mixture Screws

⚠ WARNING

Avoid fire or explosion. Using a cutting wheel to cut the seals will cause sparks, which will ignite any fuel that is present. Ensure that there is no fuel present and that carburetor is removed from engine prior to cutting the seals from the carburetor idle mixture screws.

1. Remove carburetor from the engine.
2. Drain all fuel from the carburetor.
3. Using a cutting wheel, make a cut on both sides of the seal casing. Using a suitable device, pry the plug from the inside of the seal. Once the plug is removed, the idle mixture screw can be removed and the seal casing can be removed.



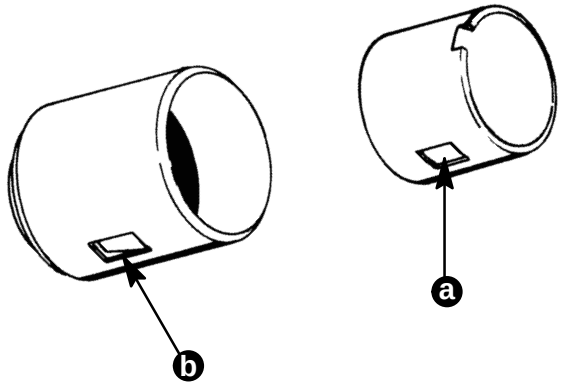
73744

Installing New Seals

1. Install new seal cup, spring and idle mixture screw.

IMPORTANT: Do not install the seal plug until the "Propane Assisted Idle Mixture Adjustment" procedure has been completed.

2. Align the opening in the plug with the tab on the cup and push down until it snaps in place.

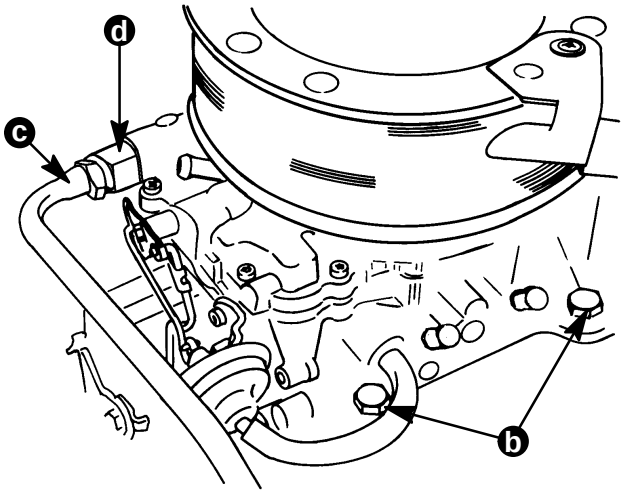


73789

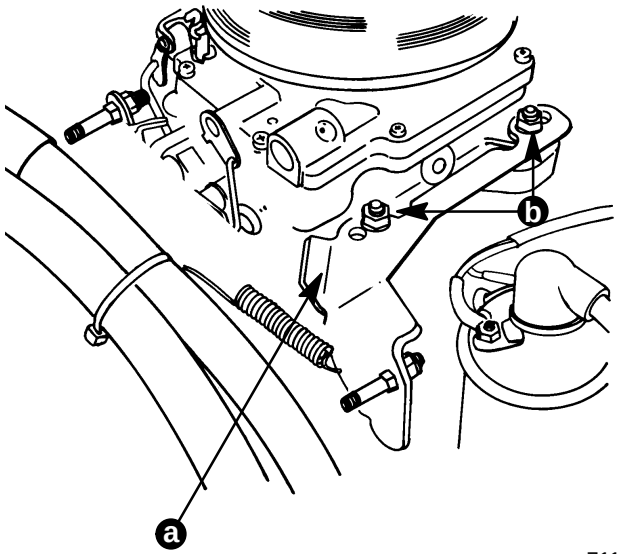
a - Opening In Plug
b - Tab On Cup

Carburetor Installation

3. Install new carburetor as follows:
   a. Place new gasket on adapter plate.
   b. Install carburetor and throttle bracket and secure with new attaching hardware. Torque fasteners to 132 lb.in. (15 N·m).
   c. Connect fuel line. To prevent over-tightening, hold fuel inlet nut with a suitable wrench and tighten fuel line connector securely.



71173



71172

a - Throttle Bracket
b - Attaching Hardware
c - Fuel Line
d - Fuel Inlet Nut

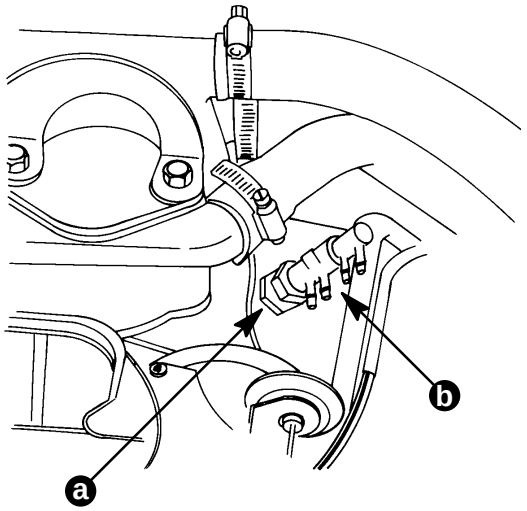
Ported Vacuum Switch Installation

⚠CAUTION

Be careful not to break off fittings when installing the ported vacuum switch (PVS) in the following step.

NOTE: *A special tool is available to install the PVS. Refer to the "Tool Chart" at the beginning of this manual.*

1. If removed, install ported vacuum switch (PVS) into reducer bushing. Apply Loctite Pipe Sealant with Teflon to threads before installing. Tighten it securely and position the fittings toward back of engine as shown.



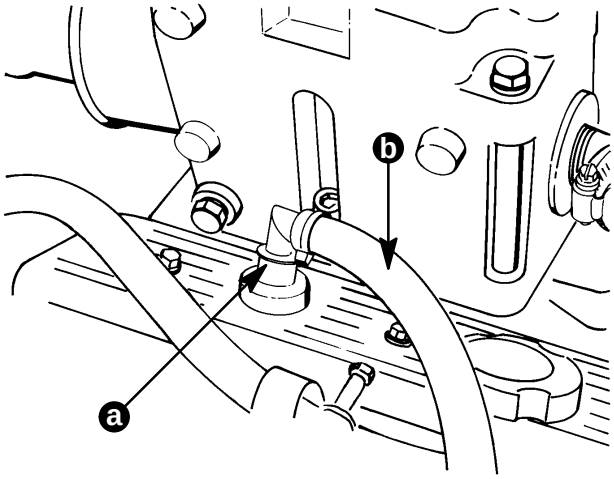
71913

a - Reducer Bushing
b - Ported Vacuum Switch (PVS)

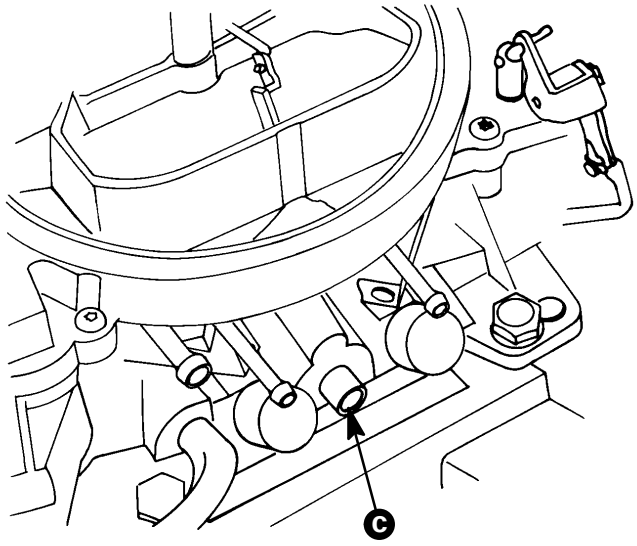
Index

Emissions System Connections

1. Install the positive crankcase ventilation (PCV) valve in the port valve cover.
2. Connect hose to PCV valve. Connect opposite end of hose to fitting on front of carburetor.



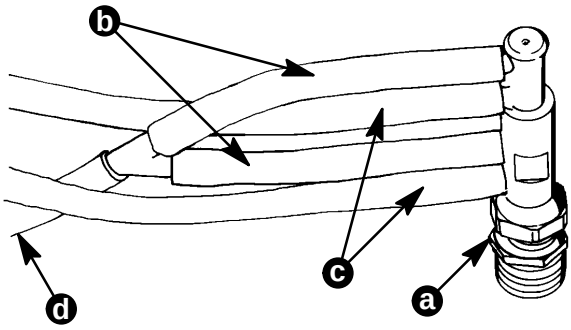
71925



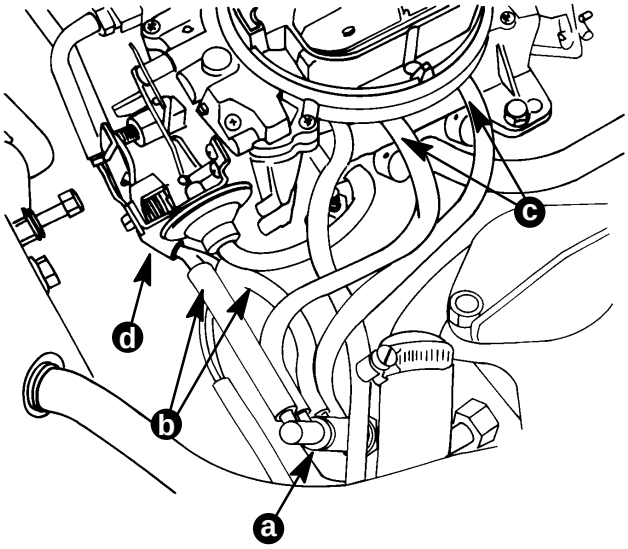
73701

a - PCV Valve
b - Hose
c - Carburetor Fitting (Connect Hose Here)

3. Connect hoses to ported vacuum switch (PVS) as shown.



71924

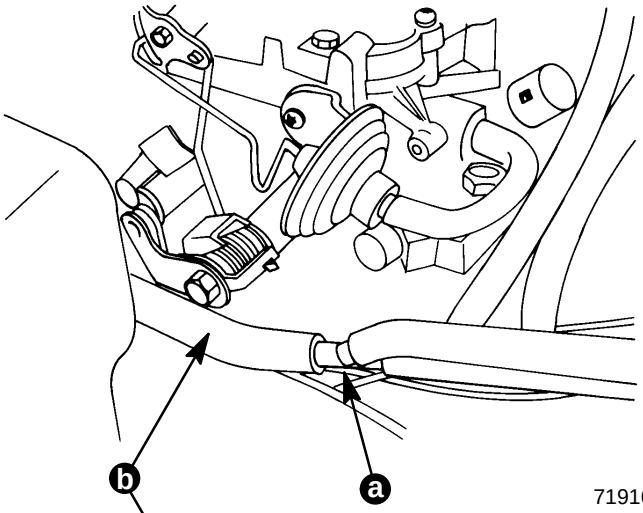


a - Ported Vacuum Switch
b - Hoses (Switch To Y-Fitting)
c - Hoses (To Front Side Of Carburetor)
d - Hose (Y-Fitting To Back Side Of Carburetor)

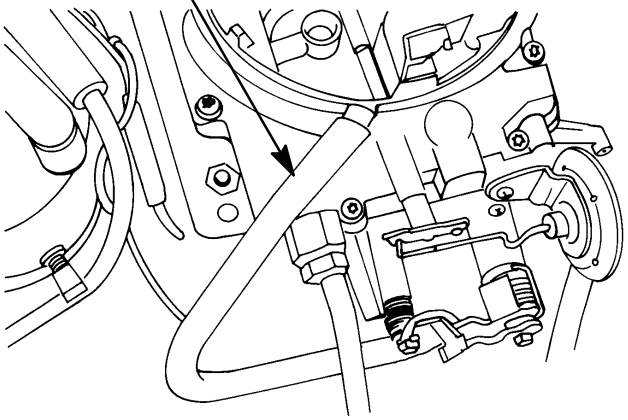
73702

Index

IMPORTANT: The hose that runs from the T-Fitting to the back side of the carburetor must be routed beneath the throttle linkage as shown in the following illustration. Use care to ensure that the hose does not rub against linkage.



71916



71917

a - T-Fitting
b - Hose - T-Fitting T Back Of Carburetor

Propane Assisted Idle Set Procedure

⚠ WARNING

Avoid fire or explosion. Observe the following precautions when performing this procedure.

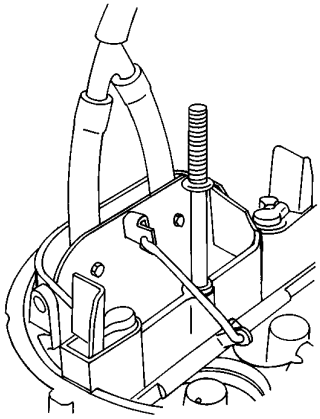
- **Do not operate the engine without the flame arrestor installed, above the speeds listed in this procedure.**
- **Propane is extremely flammable and explosive. Ensure that the following test is performed in a well ventilated area with the engine hatch open.**
- **Ensure that there is no spark or open flame in the test area.**
- **Do not start the flow of propane until the hose has been placed into the carburetor and the engine has been started.**
- **Keep a fire extinguisher available when performing this test.**

NOTE: *This test must be performed any time the carburetor has been disassembled and internal components have been disturbed or the idle mixture screws have been tampered with. The test should also be performed if other component parts of the emissions system have been altered, repaired, or replaced.*

IMPORTANT: Ensure that the PVS is functioning properly before performing this procedure.

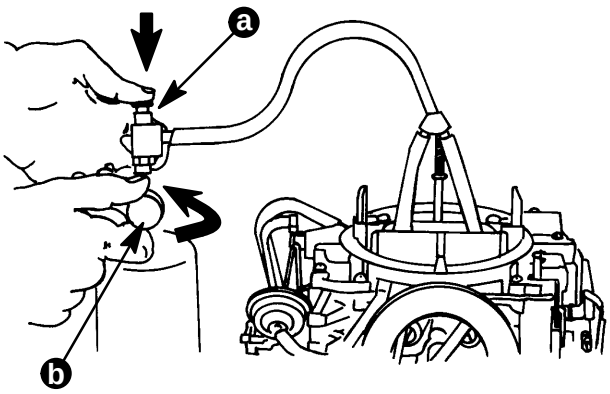
1. As a starting point, set both idle mixture screws at 1 turn out from the fully seated position.
2. Start engine and allow it to warm up to normal operating temperature. If engine has been run above idle speed, allow engine to idle for 3 to 5 minutes to stabilize the engine.
3. Remove flame arrestor.

4. Insert special “Y”-Adapter hoses into carburetor as shown. Place the hoses behind the choke plate to help hold them in place.



73731

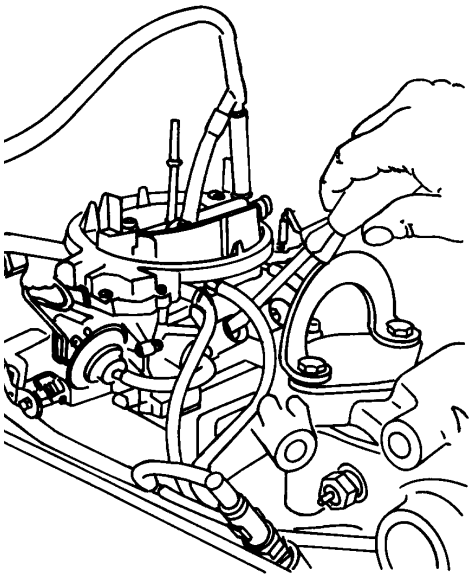
5. Connect the hose from the propane bottle valve to the “Y”-Fitting.
6. With engine idling at normal operating temperature, press the propane flow button on the valve. Slowly begin opening the propane metering valve until maximum engine RPM is reached. When too much propane is added, engine RPM will decrease. “Fine tune” the metering valve to obtain the highest RPM.



73673

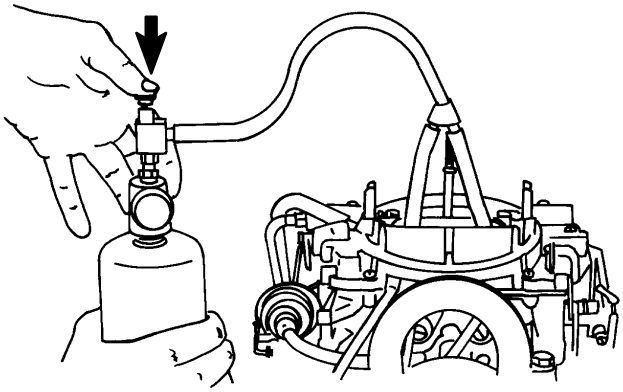
a - Propane Flow Valve
b - Propane Metering Valve

7. With propane still flowing, adjust the idle speed screw (not the mixture screws) to obtain 850 RPM. Again, “fine tune” the propane metering valve to obtain the highest engine RPM. If there has been a change in the maximum RPM, readjust the idle speed screw to 850 RPM.
8. Release the propane flow valve and allow engine speed to stabilize. Slowly adjust the mixture screws by equal amounts, pausing between adjustments to allow engine speed to stabilize, to achieve 775 RPM.



73722

9. Press the propane flow valve. Engine RPM should increase to 850 RPM. If it does not, repeat steps 5 thru 7.



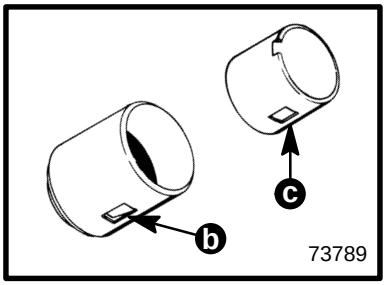
73662

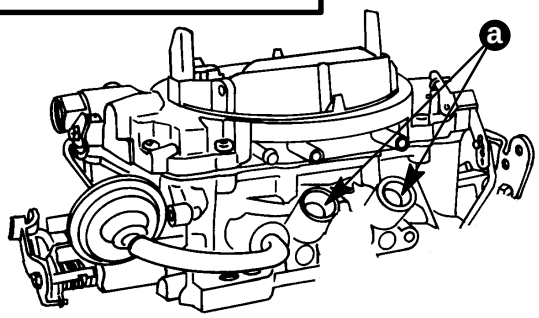
10. If after performing the above procedure several times, the correct results can still not be obtained, check the following:

- PVS not working properly.
- Incorrect float level.
- Vacuum leaks.

Index

11. Once the idle speed and mixture adjustment is correct, install the seal plugs over mixture screws. Ensure the opening in plug snaps into the tab in the cup.





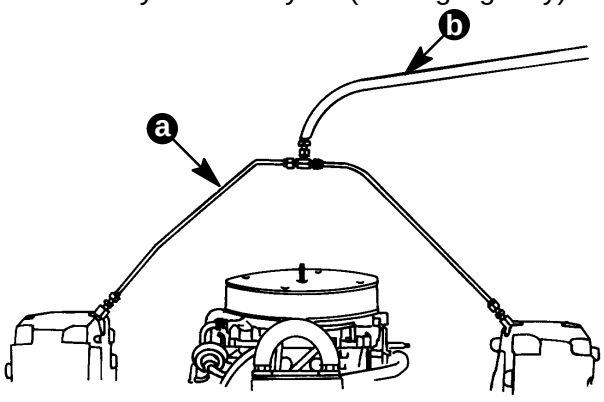
a - Screw Seal
b - Tab In Cup
c - Opening In Cup

12. Reinstall the flame arrestor.

Test Equipment

The following equipment is needed to perform an emissions test on this engine:

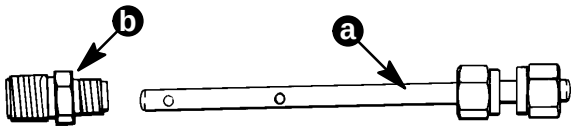
- Test Probes (Supplied in Kit).
- Test Probe Collector (Testing Agency).
- Exhaust System Analyzer (Testing Agency).



a - Exhaust Probe Collector
b - To Exhaust Analyzer

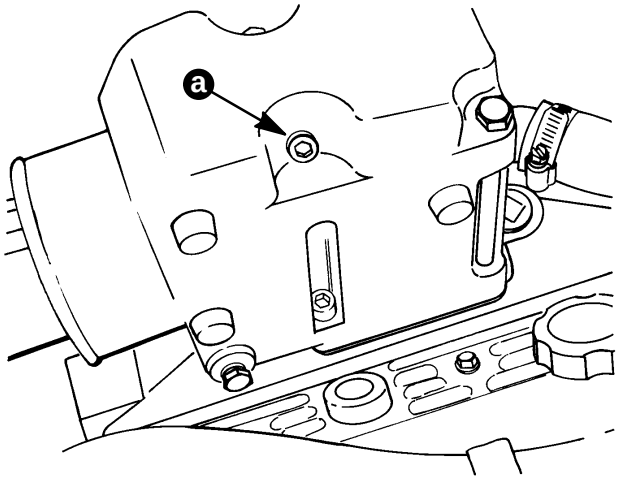
Emissions Testing

NOTE: *This test will be performed by an authorized agency for the area that the boat will be operated. This agency will be equipped with the appropriate test equipment and adapters for this engine. The only item that must be supplied by the boat owner/operator are the exhaust test probes. These test probes should be carried aboard the vessel* at all times*. The following steps will explain how these probes are to be installed.*



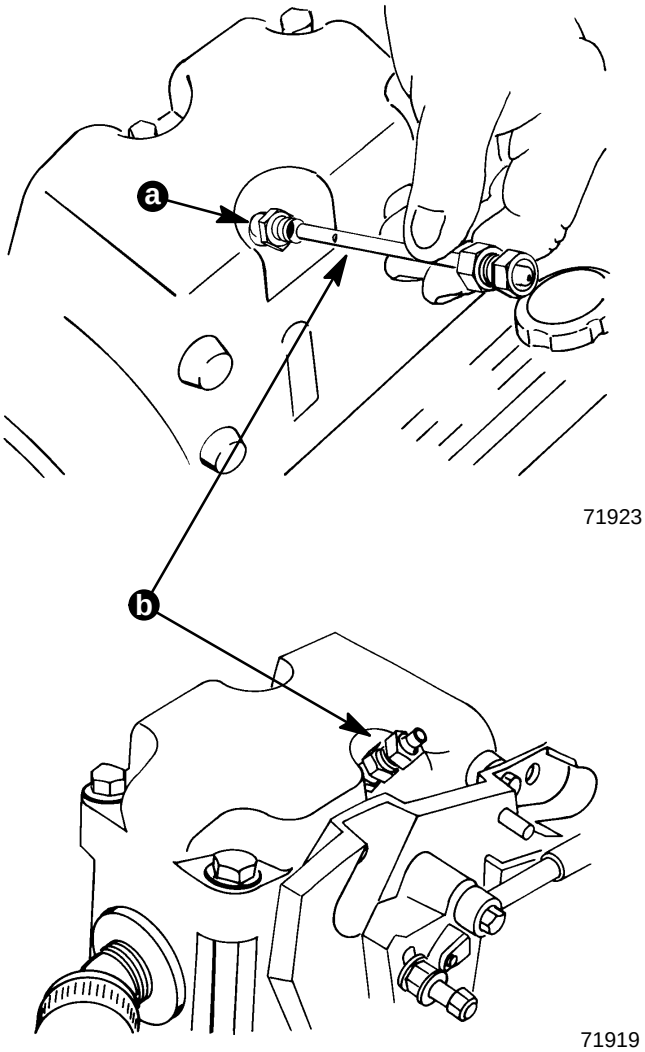
a - Exhaust Test Probes (2)
b - Exhaust Elbow Adapter Fittings (2)

1. Remove plugs from both exhaust elbows.



a - Plugs (Port And Starboard Elbows)

2. Install exhaust elbow adapter fittings into elbows. Apply Loctite Pipe Sealant with Teflon to threads that go into elbow. Tighten securely.
3. Insert exhaust test probes into fittings and tighten securely.



71923

71919

a - Fittings
b - Exhaust Test Probes

4. When exhaust emissions test is complete, remove test probes and adapter fittings and reinstall the plugs. Apply Perfect Seal to threads before installing. Tighten them securely.

NOTE: *Be certain to place test probes and adapter fittings in suitable storage aboard the boat for use in the future.*

NOTICE TO OWNER/OPERATOR

Your engine is equipped with special design features and special tuning to minimize the emission output from the engine. You should follow:

- **Recommended maintenance schedules particularly as to the ignition system.**
- **Proper engine tuning procedures to ensure these features remain in good operating order.**
- **Proper steps to maintain the engine within specification.**

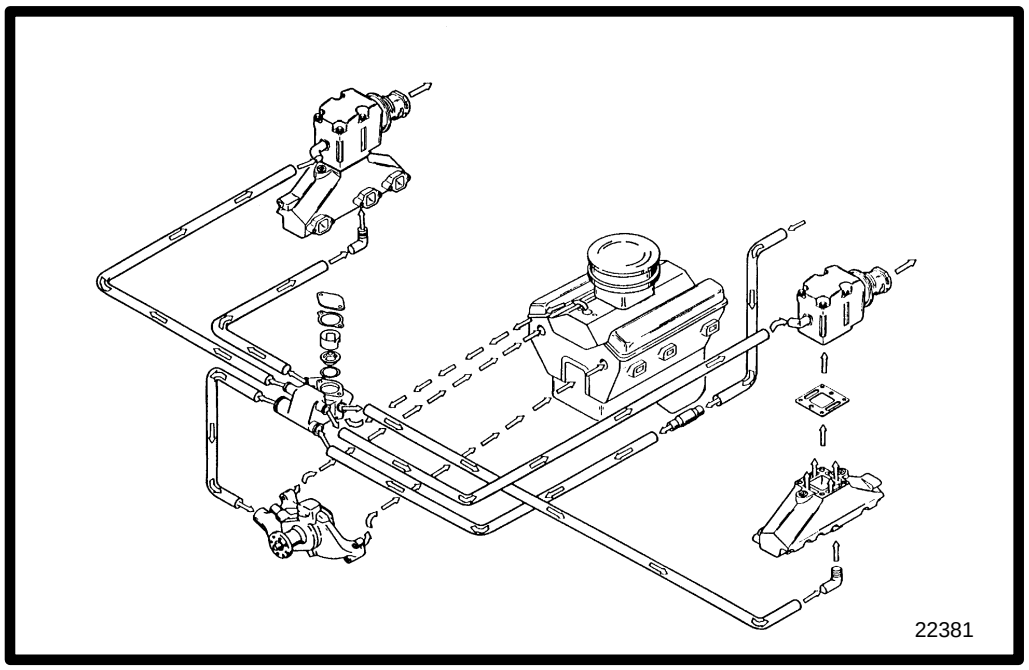
The instructions in the Emissions Kit provide the necessary information to properly convert the engine to meet the applicable Bodensee Regulations. There is another item within the regulation that is beyond the control of Mercury Marine. This item is related to the fuel filling system on the boat. The requirements for the fuel filler neck are as follows:

- **Must be designed so that it is impossible to use a fuel nozzle with an outside diameter of more than 23.6 mm.**
- **The filler neck shall be durable and designed so that modifications are not possible.**
- **A durable, legible plate shall be mounted on the boat near the fuel filler neck. This plate shall read: “UNLEADED GASOLINE ONLY”.**

Any questions about the fuel filler neck requirement and availability of the required components should be directed to the boat manufacturer.

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

COOLING SYSTEM



6
A

SEAWATER COOLING MODELS

Index

Table of Contents

	Page
MCM 262 CID / 4.3L Alpha (Two Piece Manifolds Shown, One Piece Similar)	6A-2
MCM 262CID / 4.3L Bravo (Two Piece Manifolds Shown, One Piece Similar)	6A-3
Seawater Inlet Recommendations	6A-4
Transom Mounted or Thru-Hull Seawater Pickups and Hose	6A-4
Seacock (Seawater Inlet Valve)	6A-4
Sea Strainer	6A-4
Seawater Pickups	6A-5
Thru-Hull Mounted	6A-5
Transom Mounted	6A-5
Sea Strainer (Quicksilver)	6A-6
Removal	6A-6
Installation	6A-7
Stern Drive Unit Seawater Pickup Pump Output Test	6A-8
Stern Drive Unit Seawater Pickup Pump Repairs	6A-9
Water Circulating Pump Replacement	6A-9
Removal	6A-9
Cleaning and Inspection	6A-9
Installation	6A-9
Flushing Seawater Cooling System	6A-10
Engines with Stern Drive Seawater Pickup Pump	6A-10
Check/Clean Seawater Strainer	6A-10
Thermostat	6A-11
Removal	6A-11
Testing	6A-12
Installation	6A-13
Draining Seawater Cooling System	6A-14
Draining Precautions	6A-14
Auxiliary Hot Water Heater Installation Information	6A-17

MCM 262 CID / 4.3L

TORQUE SPECIFICATIONS

DESCRIPTION	Lb. In.	Lb. Ft.	N·m
Alternator Brace to Alternator	192		28
Alternator Brace to Block		30	41
Alternator to Mounting Bracket			
Alternator/Power Steering Pump Mounting Bracket			
Power Steering Pump Brace to Block			
Power Steering Pump Bracket			
Thermostat Cover			
Thermostat Housing			
Water Circulating Pump			
Water Temperature Sender		20	27
Drain Plugs (See Note)	Securely		
Hose Clamps			
Petcocks			
Pulleys			

Note: Coat threads with Quicksilver Perfect Seal before installing.

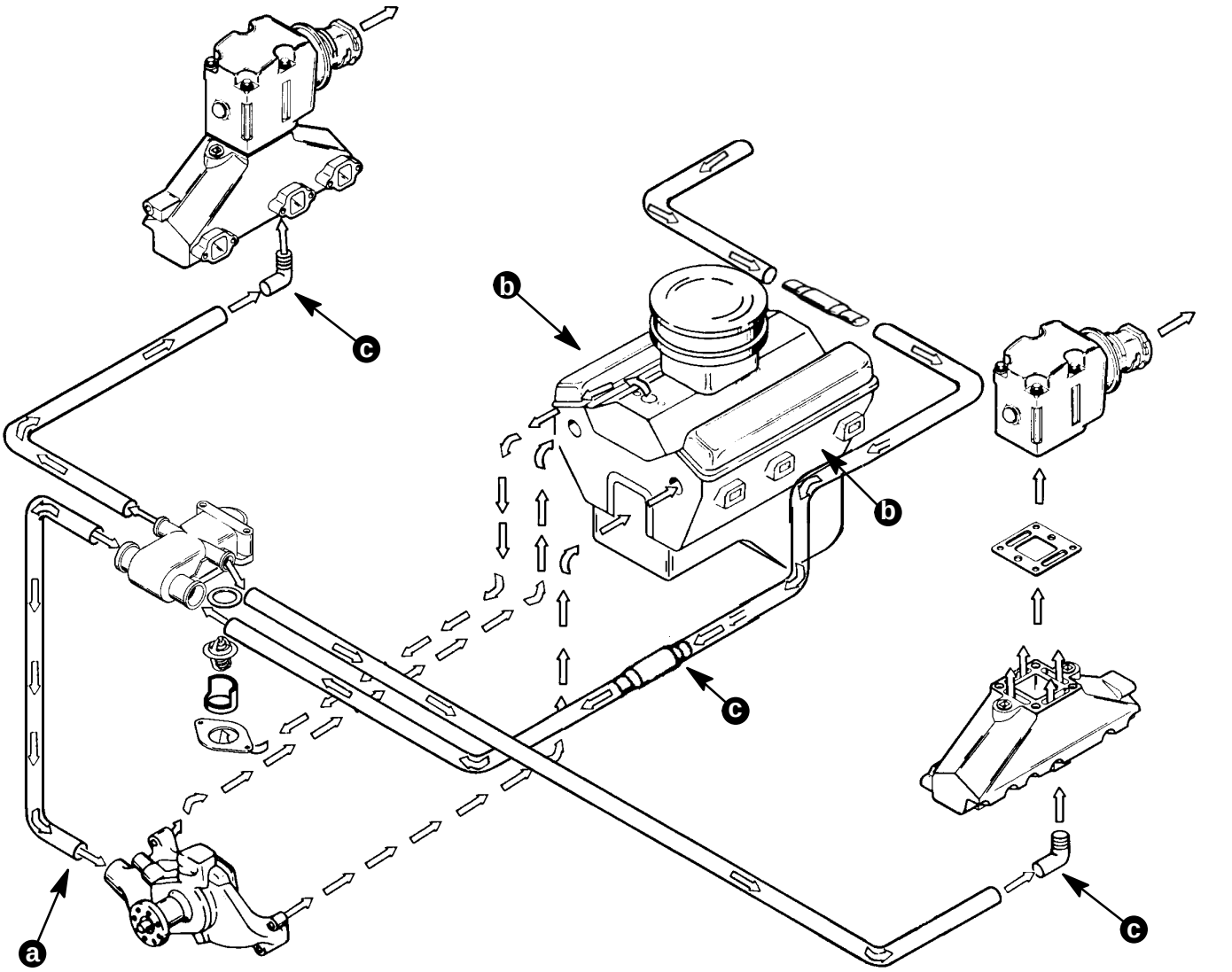
TOOLS/LUBRICANTS/SEALANTS

DESCRIPTION	PART NUMBER
Quicksilver Perfect Seal	92-34227-1
Quicksilver Flushing Attachment	73971A2
Quicksilver Liquid Neoprene	92-25711--2
Loctite Pipe Sealant with Teflon	Obtain Locally
Marine Caulking	

SPECIFICATIONS

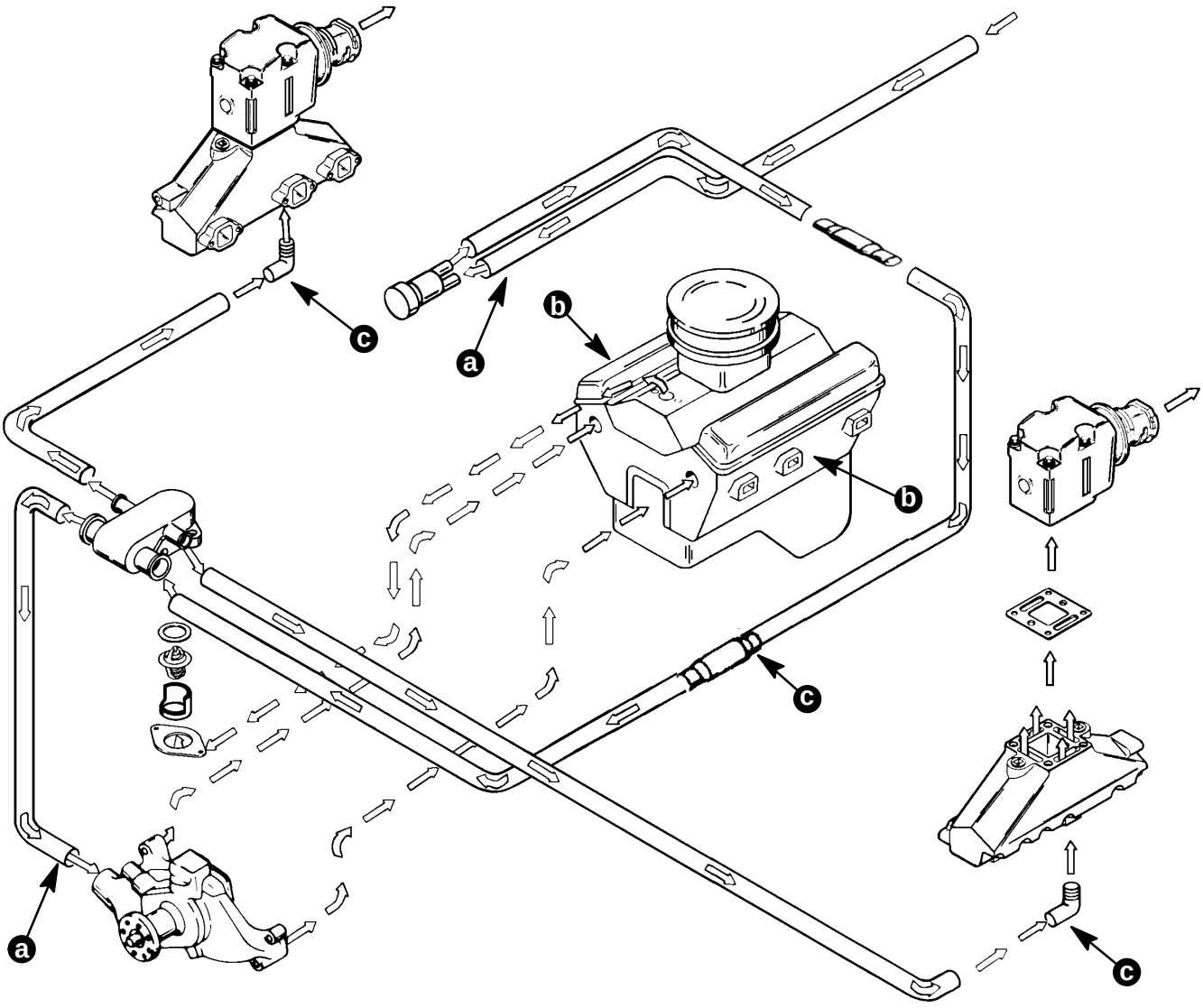
Cooling System Capacity	15 Qts (14L)
Thermostat (Type) Stainless Steel	160° F (71° C)
Thermostat (Type) Brass	143° F (60° C)

MCM 262 CID / 4.3L Alpha (Two Piece Manifolds Shown, One Piece Similar)



a - Remove Hoses (Lift, Lower or Bend To Completely Drain).
b - Remove Block Plugs (Repeatedly Clean Out Holes Using A Stiff Wire Until Entire System Is Drained).
c - Remove Drain Plugs From Exhaust Exhaust Manifold Drain Elbows and Fuel Cooler or Water Tube (Repeatedly Clean Out Holes Using A Stiff Wire Until Entire System Is Drained)

MCM 262CID / 4.3L Bravo (Two Piece Manifolds Shown, One Piece Similar)



74818

a - Remove Hoses (Lift, Lower or Bend To Completely Drain).
b - Remove Block Plugs (Repeatedly Clean Out Holes Using A Stiff Wire Until Entire System Is Drained).
c - Remove Drain Plugs From Exhaust Exhaust Manifold Drain Elbows and Fuel Cooler or Water Tube (Repeatedly Clean Out Holes Using A Stiff Wire Until Entire System Is Drained)

Seawater Inlet Recommendations

Transom Mounted or Thru-Hull Seawater Pickups and Hose

Water pickup must be large enough to permit sufficient water flow to engine seawater pickup pump for adequate engine cooling [30 gal. per min. (114 L per min.) minimum]. Pickup also must supply a positive head while underway.

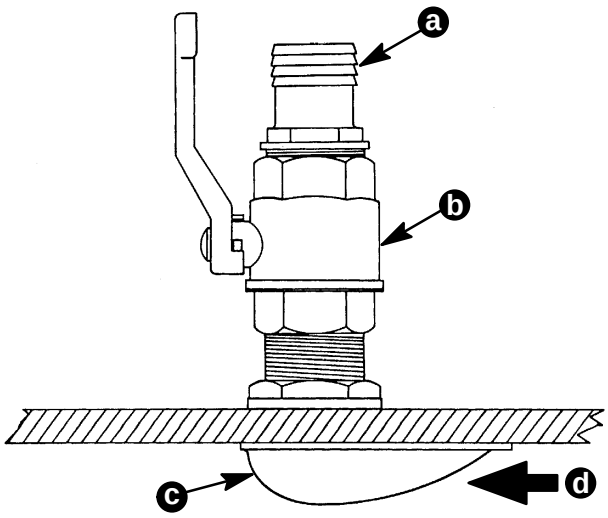
⚠CAUTION

Do not install water pickup directly in line with propeller, as pickup may create turbulence and allow air to flow into the "propeller slipstream." This will cause propeller ventilation and will adversely affect boat performance.

Water pickup should be located as close to seawater pickup pump inlet as possible and in an area where an uninterrupted, solid stream of water will flow past when boat is underway. Connect water pickup to seawater pickup pump inlet with 1-1/4 in. (32 mm) I.D. wire reinforced hose of adequate wall thickness to prevent it from collapsing from pump suction. Be sure to secure hose connections with hose clamps.

Seacock (Seawater Inlet Valve)

If a seacock is being used, it must be installed between water pickup and seawater pickup pump (or sea strainer), to allow operator to shut off the seawater in case of a leak or when boat is not in use. This will allow the operator to flush or drain the engine, or clean the sea strainer while boat is in the water. Seacock used must have an internal cross-sectional area equal to or greater than hose to prevent restricting water flow. Install seacock in an area where it will be easily accessible and self-supporting to prevent hose fatigue.



70355

Seacock (With Thru-Hull Pickup Shown)

a - Hose Connector [1-1/4 In. (32mm) I.D.] to Seawater Pump Inlet
b - Seacock [1-1/4 In. (32mm)] Brass Ball or Gate Valve
c - Seawater Pickup
d - Direction of Seawater Flow

Sea Strainer

If boat is equipped with a sea strainer, it must be of sufficient size to ensure that an adequate supply of water is maintained for engine cooling. Install seawater strainer in an area where it will be easily accessible for inspection and cleaning. Strainer should be installed in water inlet hose after water inlet valve to allow operator to shut off water when cleaning strainer.

Seawater Pickups

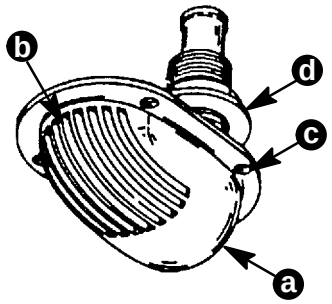
NOTICE

Refer to manufacturer's instructions for information on removal and installation of other than Quicksilver Seawater Pickups.

IMPORTANT: Seal the inside edges of any hole made through the hull with a suitable sealant to prevent water absorption and deterioration.

Thru-Hull Mounted

(Quicksilver 68670A2)



72639

Quicksilver Thru-Hull Seawater Pickup Shown

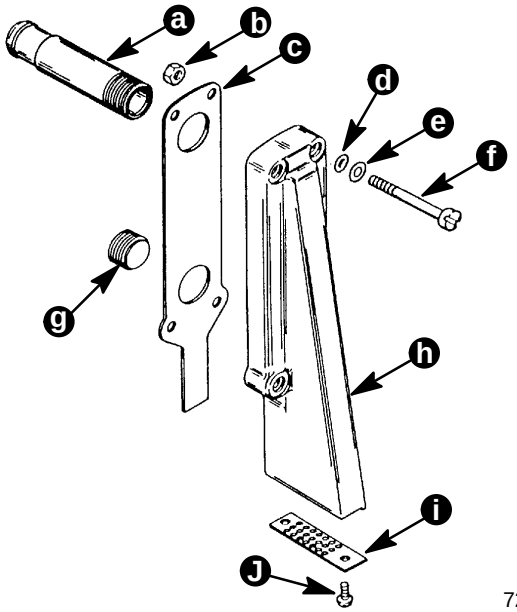
a - Seawater Pickup
b - Seawater Inlet Slot (MUST Face Forward - Parallel with Water Flow
c - Mounting Screw Holes (If So Designed)
d - Nut

1. Seal inside edges of 1-3/4 in. (44 mm) hole in hull using a suitable sealer.
2. Apply marine caulking (sealer) to mounting surface on seawater pickup where hull contact will occur when installed.
3. Ensure slots in seawater pickup are facing forward (toward bow of boat) and install seawater pickup through hull. The slots must be parallel with flow of water.
4. Fasten pickup with four appropriate mounting screws (if so designed).
5. Apply marine caulking as needed inside boat. Apply Loctite to threads of nut and install on pickup on inside of boat and torque nut to 35 lb. ft. (42 N•m).

NOTE: *If pickup being used does not have mounting screws on underside where mounted to hull, be certain, after nut is torqued, that slots are still facing forward.*

Transom Mounted

(Quicksilver Part Number: 88845A1)



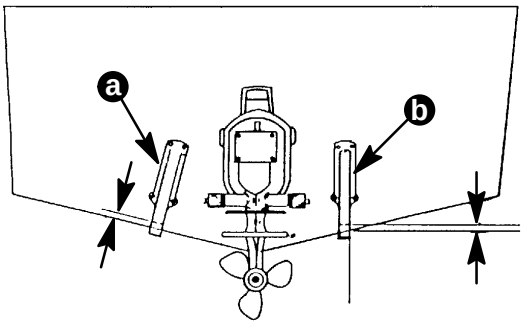
72640

Seawater Pickup Installation

a - Hose Nipple
b - Nuts (4)
c - Gasket - Between Pickup and Transom
d - O-Ring (4)
e - Washer (4)
f - Screw (4)
g - Plastic Plug
h - Pickup
i - Screen
j - Screw

1. Seal the inside edges of the 1-1/2 in. (38 mm) hole for hose nipple.
2. Be certain hose nipple and plastic plug are in place and threads have been sealed with Loctite Pipe Sealant with Teflon prior to tightening each securely.
3. Position one flat washer and one rubber O-ring on each 5/16 in. x 4 in. (102 mm) long, round head screw as shown. Coat each screw shaft with silicone sealant or equivalent.
4. Place new gasket on pickup housing and hold pickup in place on transom. Install four round head screws (with washers and O-rings in place) into pickup mounting holes and through drilled 21/64 in. (8.5 mm) holes in transom.

NOTE: *Some installations may have 7/32 in. (5.5 mm) holes drilled in transom using four 5/16 in. diameter stainless steel lag bolts in place of round head screws. In any case, flat washers and O-rings are required as outlined.*



72641

Water Pickup Installed on Transom

a - Diagonal Mount - Leading Edge of Pickup 1/8 In. (3mm) from Boat Bottom

b - Vertical Mount - Corner of Leading Edge of Pickup 1/8 In. (3mm) from Boat Bottom

5. Secure water pickup from inside with locknuts and washers (unless using lag bolts).
6. Tighten fasteners securely.

Sea Strainer (Quicksilver)

NOTICE

Refer to manufacturer's instructions for information on removal and installation of other than Quicksilver Sea Strainer.

Removal

⚠CAUTION

If boat is in water while working on seawater strainer, close seacock, if so equipped. If boat is not equipped with a seacock, remove and plug seawater inlet hose to prevent a siphoning action that may occur, allowing seawater to flow from the drain holes or removed hoses and enter boat.

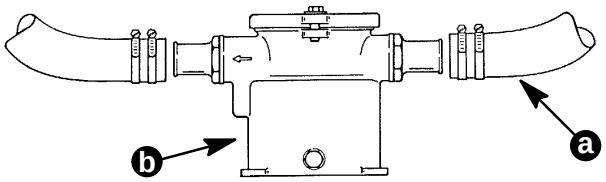
IMPORTANT: Be certain engine is off and cooling system is cold.

1. Follow "a" or "b" instructions:

   a. **Models Equipped with Seacock:**

      (1) Close seacock (seawater inlet valve).

      (2) Disconnect seawater inlet hose from seawater strainer.

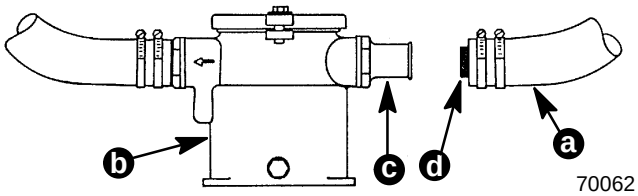


72691

a - Seawater Inlet Hose
b - Seawater Strainer

   b. **Models without Seacock:**

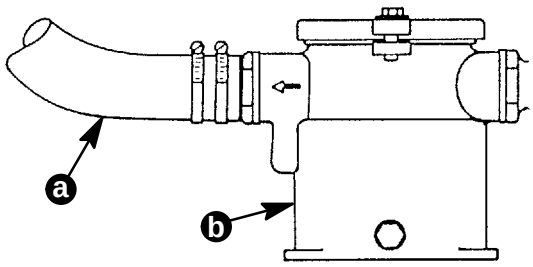
      (1) Disconnect seawater inlet hose from seawater strainer inlet and plug seawater inlet hose.



70062

a - Seawater Inlet Hose
b - Seawater Strainer
c - Seawater Strainer Inlet
d - Plug

2. Remove outlet hose. Drain into a suitable container.



72643

a - Seawater Outlet Hose
b - Seawater Strainer

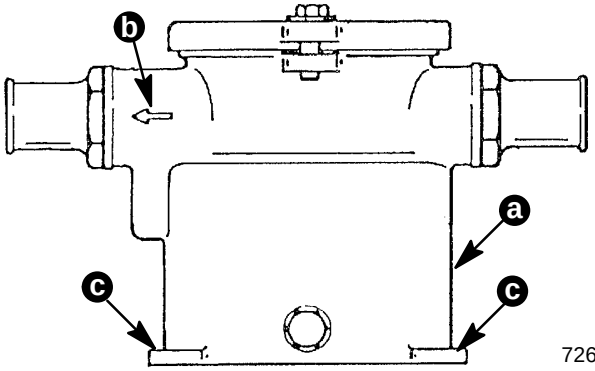
3. Remove mounting bolts. Remove strainer.

Installation

IMPORTANT: Mount seawater strainer in a vibration-free location. Never mount it on the engine or transmission. Hoses must not be kinked or allowed to come in contact with hot or moving engine or transmission parts.

1. Mount seawater strainer (Arrow must point toward seawater pump.)

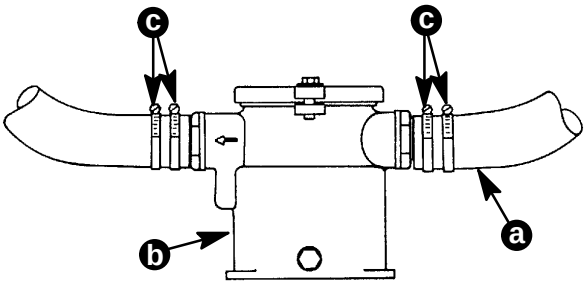
Tighten mounting bolts securely.



72644

a - Seawater Strainer
b - Arrow
c - Mounting Bolt Hole Location (Bolts Not Shown)

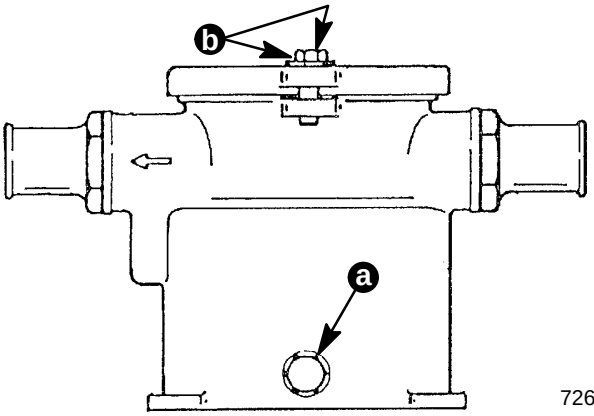
2. Install inlet and outlet hoses. Use two hose clamps on each hose connection. Tighten clamps securely.



72645

a - Seawater Inlet Hose
b - Seawater Strainer
c - Double Hose Clamps

3. Check drain plug and lens cover bolts. Tighten securely. Do not over-tighten cover bolts or cover may warp and leak water into boat.



72644

a - Drain Plug
b - Lens Cover Bolt (2, One Hidden in This View)

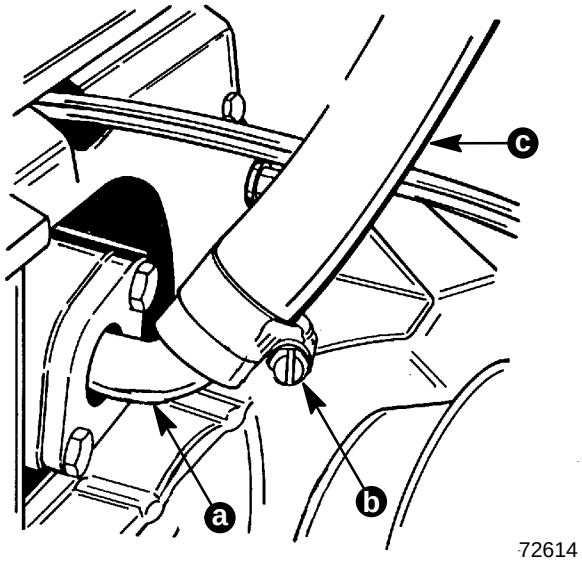
Stern Drive Unit Seawater Pickup Pump Output Test

If an overheating problem exists, use this test to determine if a sufficient amount of water is being supplied to cool engine.

IMPORTANT: The following information should be observed before proceeding with test:

- **BOAT MUST BE IN THE WATER FOR THIS TEST. This test CANNOT BE performed with a flush-test device and water hose.**
- **The ability of this test to detect a problem is greatly dependent upon the accuracy in which it is performed. An error in setting the engine RPM, timing the test or measuring the water output will affect the overall accuracy of the test and may produce misleading results. To help ensure accurate results, a shop tachometer with an error of less than 5% should be used. The boat tachometer definitely should not be used as its accuracy is questionable. A stop watch should be used to time the duration of the test to help ensure that the accuracy is maintained within one second. An 8 U.S.qt. (7.6 L) or larger capacity container should be used to measure water output.**
- **Due to the manner in which this test is performed, it may not be possible to detect a marginal condition or a high-speed water pump output problem.**

1. Remove water inlet hose, which runs between gimbal housing water tube and engine, and replace with another hose of same diameter, but approximately 3 ft. (1 m) longer. Hose should be wire reinforced or of adequate wall thickness to prevent it from kinking when performing test. Clamp hose at gimbal housing water tube only. Do not clamp hose at engine end.



72614

a - Water Tube
b - Hose Clamp
c - Water Hose

2. Place an 8 U.S. qt. (7.6 L) or larger container near unclamped end of hose.

⚠CAUTION

Do not run engine for more than 15 seconds with hose disconnected, in next step, as internal damage to engine and exhaust system may result.

3. With assistance of another person, start engine and adjust speed to exactly 1000 RPM while holding unclamped end of hose on connection on engine. Remove hose from connection on engine and direct water flow into container for exactly 15 seconds. At the end of 15 seconds, direct the water flow overboard, return engine to idle and stop engine. Reconnect hose to engine.
4. Measure quantity of water discharged into container and compare with specifications given in chart following.

5. Repeat test four times to check repeatability of results.

Alpha Stern Drive Pump Output for 15 Second Period	
Drive Unit Gear Ratio	**Minimum Quantity U.S. Qts. (L)**
1.98:1	3.0 (2.8)
1.84:1	3.3 (3.1)
1.65:1	3.6 (3.4)
1.50:1	4.0 (3.8)
1.32:1	4.5 (4.3)

Stern Drive Unit Seawater Pickup Pump Repairs

NOTICE

MCM (Stern Drive) Models equipped with Alpha Drive Units have a seawater pickup pump mounted in stern drive unit. Refer to appropriate Stern Drive Service Manual for further testing and repairs.

Water Circulating Pump Replacement

Removal

1. Drain water from cylinder block. Refer to “Draining Seawater Cooling System” as outlined later in this section.
2. Loosen circulating pump pulley attaching bolts. Do not remove bolts at this time.
3. Loosen power steering pump brace and pump mounting bolts, then pivot pump inward and remove drive belts.
4. Loosen alternator brace attaching bolts and alternator mounting bolt, then pivot alternator inward and remove drive belt.
5. Remove pump pulley attaching bolts, lockwashers, clamping ring (if so equipped) and pulley.
6. Disconnect hose(s) from pump.
7. Remove bolts, which secure pump to cylinder block, and remove pump and old gaskets (discard gaskets).

Cleaning and Inspection

1. Clean gasket surfaces on water pump and cylinder block.
2. Inspect water pump for blockage, cracks, sand holes, corrosion or other damage. Inspect pump impeller for cracks and erosion. Replace complete pump if any damage exists.
3. Check impeller shaft and bearings for excessive side play. If play can be felt, replace complete pump.
4. Inspect pump pulley for bends, cracks, corrosion or other physical damage. Inspect pulley for rotational trueness. Replace pulley if damaged or untrue.

Installation

1. Coat both sides of new circulating pump gasket with Quicksilver Perfect Seal, then position gaskets and circulating pump on cylinder block. Coat threads of circulating pump attaching bolts with Quicksilver Perfect Seal and install bolts and alternator brace (if applicable). Torque bolts to specifications.
2. Reconnect hoses to pump.
3. Install pump pulley and clamping ring (if used) on pump hub and secure with bolts and lockwashers. Tighten bolts securely.
4. Install drive belts and adjust tension as outlined in “Drive Belt Tension Adjustment.”
5. Start engine and check for leaks.

Flushing Seawater Cooling System

If engine is operated in salty, polluted or mineral-laden waters, seawater cooling system should be flushed periodically (preferably after each use) with fresh water to reduce corrosion and prevent the accumulation of deposits in the system. Seawater cooling system also should be thoroughly flushed prior to storage.

⚠WARNING

When flushing, be certain the area around propeller is clear, and no one is standing nearby. To avoid possible injury, remove propeller.

⚠CAUTION

Do not run engine above 1500 RPM when flushing. Suction created by seawater pickup pump may collapse flushing hose, causing engine to overheat.

IMPORTANT: If cooling system is to be flushed with boat in the water, seacock (if so equipped) must be closed, or water inlet hose must be disconnected and plugged to prevent water from flowing into boat.

⚠CAUTION

Watch temperature gauge at dash to ensure the engine does not overheat.

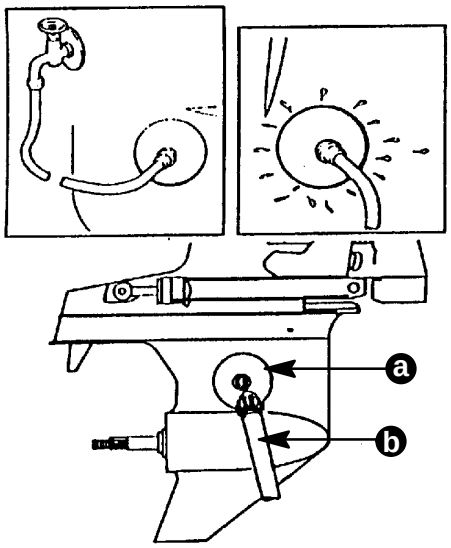
Engines with Stern Drive Seawater Pickup Pump

⚠CAUTION

To prevent engine or stern drive unit damage DO NOT run engine or drive unit without water being supplied to water intake openings on gear housing.

If flushing cooling system with boat in water, raise drive unit to trailer position, install flushing attachment and lower drive unit to full IN/DOWN position.

1. Install Quicksilver Flushing Attachment (or equivalent) over water intake openings in gear housing.
2. Connect hose between flushing attachment and water tap.



72672

a - Quicksilver Flushing Attachment
b - Garden Hose

3. With drive unit in normal operating position, partially open water tap (about 1/2 maximum) and allow cooling system to fill completely. Cooling system is full when water is discharged through the propeller. Do not use full tap water pressure.
4. Place remote control in NEUTRAL, idle speed position and start engine. Operate engine at idle speed, in NEUTRAL, for about 10 minutes, or until discharge water is clear. Watch temperature gauge on instrument panel to ensure that engine does not overheat.
5. Stop engine. Shut off tap water and remove flushing attachment

Check/Clean Seawater Strainer

NOTICE

Refer to manufacturer's instructions for information on checking and cleaning of other than Quicksilver Seawater Strainer.

1. Visually inspect seawater strainer through glass top.

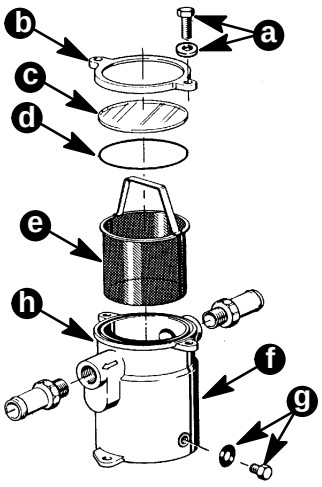
⚠WARNING

When cleaning seawater strainer, close seacock, if so equipped. If boat is not equipped with a seacock, remove and plug seawater inlet hose to prevent a siphoning action that may occur, allowing seawater to flow from the drain holes or removed hoses.

⚠CAUTION

Do not over-tighten cover screws or cover will warp and leak.

2. With engine off, close seacock, if so equipped, or remove and plug seawater inlet hose, if no seacock exists. Remove two screws and washers, and cover. Remove strainer, and drain plug and washer. Clean any debris from strainer housing; flush both strainer and housing with clean water. Check gasket; replace when necessary (if it leaks). Reinstall strainer, drain plug and washer. Reattach cover with screws and washers. Open seacock, or unplug and reconnect seawater inlet hose. Tighten hose clamps securely. After starting engine, check for leaks and/or air in system, which would indicate an external leak.



72673

Quicksilver Seawater Strainer Shown

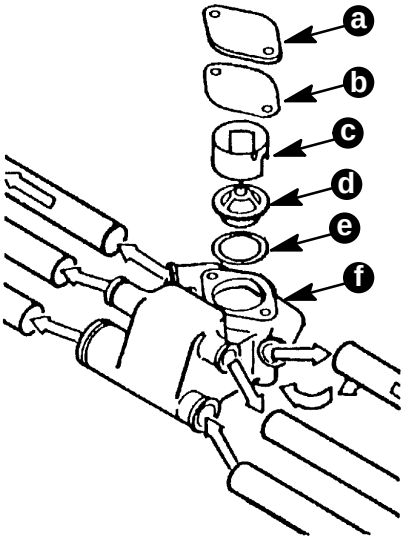
a - Screws and Washers
b - Cover
c - Glass
d - O-Ring
e - Strainer
f - Housing
g - Drain Plug and Sealing Washer
h - Gasket

Thermostat

Removal

1. Drain water from cylinder block and exhaust manifolds.
2. Remove thermostat cover attaching bolts and lockwashers, then remove cover and gasket.
3. Remove thermostat from thermostat housing or cover.

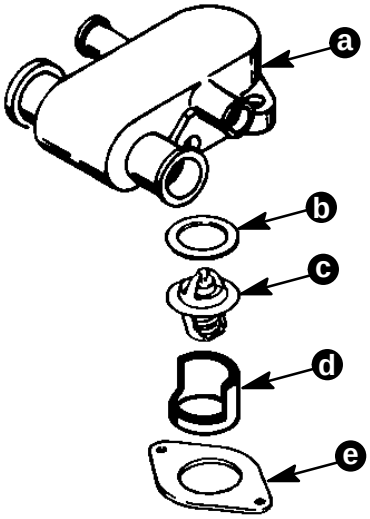
NOTE: *If equipped with a lifting eye (not shown in following), note placement of lifting eye so that it may be positioned exactly the same upon installation , or it may interfere with the fit of the flame arrestor cover.*



72589

6 Hose Thermostat Housing

a - Cover
b - Gasket
c - Spacer
d - Thermostat
e - O-Ring
f - Housing



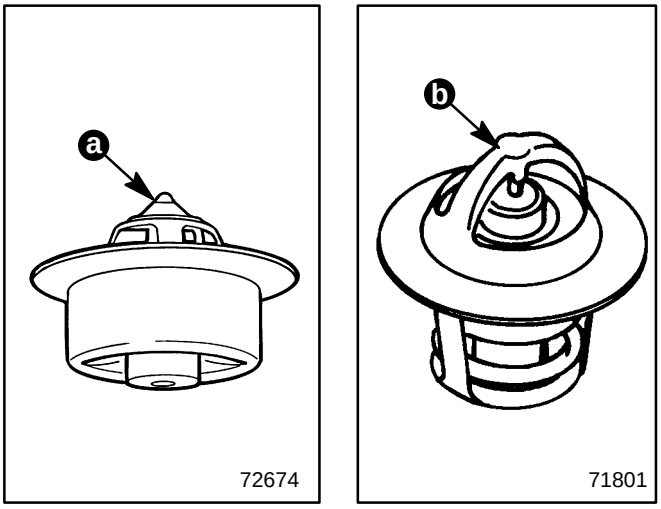
71758

4 Hose Thermostat Housing

a - Housing
b - O-Ring
c - Thermostat (Stainless Steel)
d - Spacer
e - Gasket

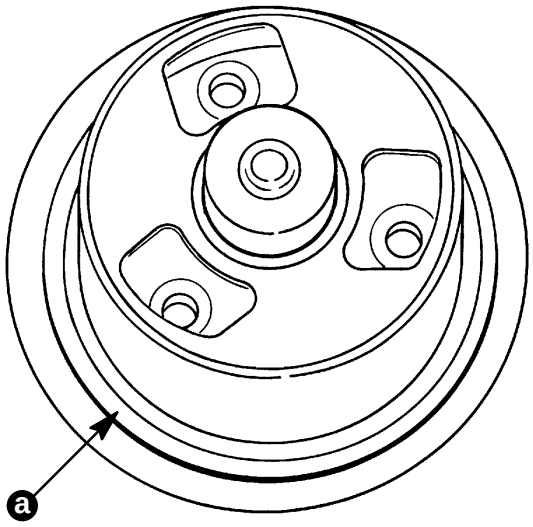
Testing

1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect thermostat for corrosion or other visible damage.



a - Brass Thermostat
b - Stainless Steel Thermostat

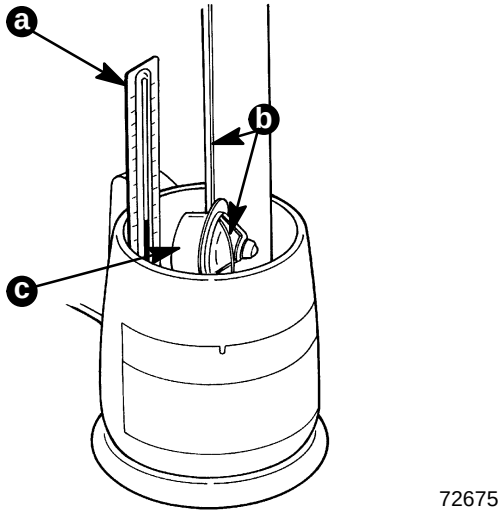
3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leakage by holding it up to a lighted background. Light leakage around the thermostat valve indicates that thermostat is not closing completely and should be replaced. (A small amount of leakage at one or two points around the valve perimeter is acceptable.)



Brass Thermostat Shown (Stainless Similar)

a - Check for Light Leakage Around Perimeter of Valve

4. Check opening and closing temperature of thermostat (using a tester similar to the one shown) as follows:
   a. Fill tester to within 1 in. (25mm) of top with tap water. Do not use distilled water.
   b. Open thermostat valve and insert nylon string. Position thermostat on string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.
   c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. Do not allow thermometer to touch container.



a - Thermometer
b - Nylon String
c - Thermostat (Typical)

IMPORTANT: When performing procedures "d"-"f," water must be agitated thoroughly to obtain accurate results.

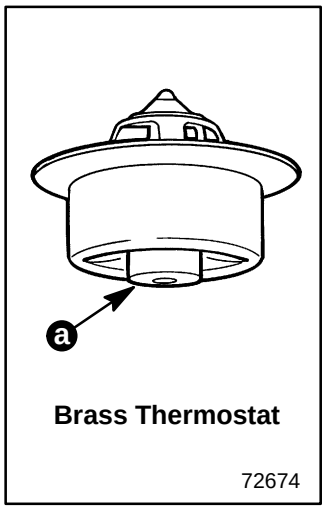
   d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread). Thermostat must open at specified temperature stamped on thermostat.
   e. Continue to heat water until a temperature 25°F (14°C) above temperature specified on thermostat is obtained. Thermostat valve must be completely open at this temperature.
   f. Unplug tester and allow water to cool to a temperature 10°F (5°C) below specified temperature on thermostat. Thermostat must be completely closed at this temperature.
   g. Replace a thermostat that fails to meet all of the preceding tests.

Installation

1. Clean gasket surfaces on thermostat cover and thermostat housing.
2. If thermostat housing was disturbed during removal of thermostat, remove thermostat housing. Clean gasket surfaces on thermostat housing and intake manifold and replace thermostat housing-to-intake manifold gasket.

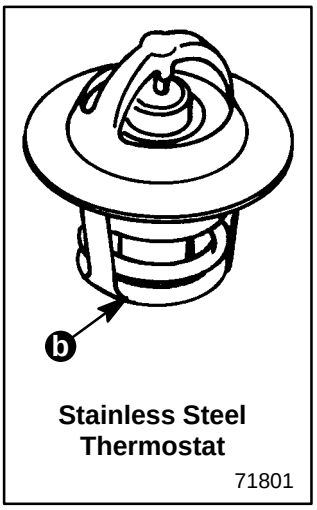
IMPORTANT: If gasket has continuity rivets, do not coat with Quicksilver Perfect Seal, or audio warning temperature switch may not work properly.

3. Place O-ring in the thermostat housing. Be certain it is positioned properly on mounting flange in housing.
4. Install thermostat in thermostat housing as shown.



Brass Thermostat

72674

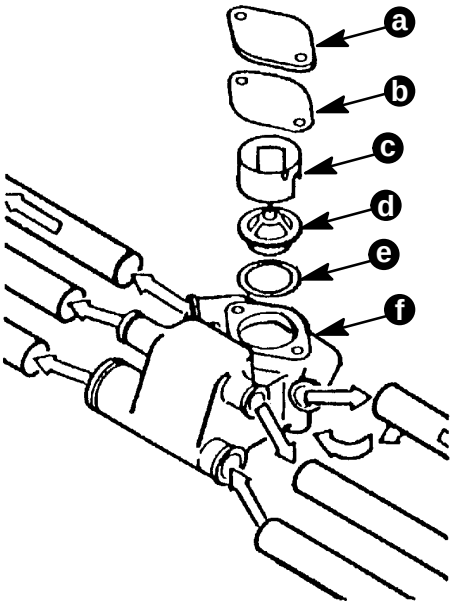


Stainless Steel Thermostat

71801

a - Install Thermostat With This End (Down) Toward Thermostat Housing

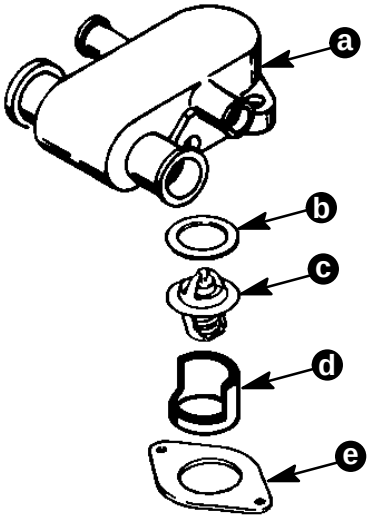
5. Align tang on sleeve with groove in thermostat housing bore and install sleeve into housing.
6. Coat both sides of new thermostat cover-to-thermostat housing gasket with Quicksilver Perfect Seal and position on housing.
7. Reinstall thermostat cover (with engine lifting eye, if so equipped) and torque screws with lockwashers to 30 lb. ft. (41 N·m).
8. Reconnect hose(s) to thermostat housing. Tighten hose clamps securely.
9. Start engine and inspect for leaks.



72589

6 Hole Thermostat Housing

a - Cover
b - Gasket
c - Spacer
d - Thermostat
e - O-Ring
f - Housing



71758

4 Hole Thermostat Housing

a - Housing
b - O-Ring
c - Thermostat (Stainless Steel)
d - Spacer
e - Gasket

Draining Seawater Cooling System

NOTICE

For cold weather or extended storage information and procedures, refer to SECTION 1B.

Draining Precautions

⚠CAUTION

If boat is in the water, seacock (water inlet valve), if so equipped, must be left closed until engine is to be restarted to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be left disconnected and plugged to prevent water from flowing back into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel of the boat with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engine.

IMPORTANT: Observe the following information to ensure complete draining of cooling system.

- **Engine must be as level as possible.**
- **A wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages.**

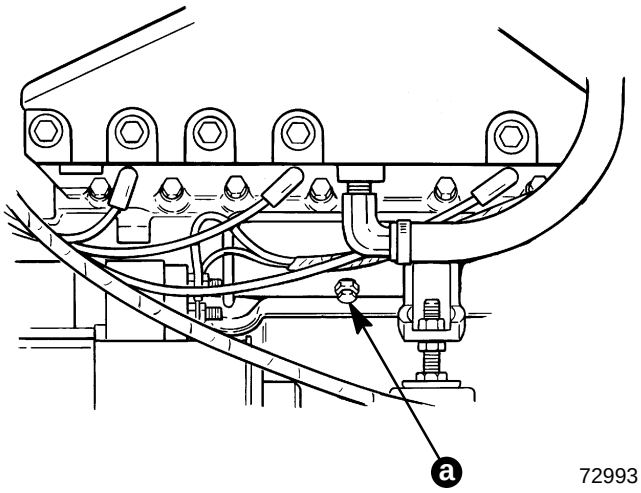
IMPORTANT: To prevent threads in manifolds, elbows and cylinder blocks from rusting out during storage, reinstall plugs using Quicksilver Perfect Seal on threads. Never leave drain plugs out during storage.

NOTE: *If possible, place a container under drains and hoses to prevent water from draining into boat.*

NOTICE

Refer to "Draining Precautions," in this section, BEFORE proceeding.

1. Check that engine is as level as possible to ensure complete draining of cooling system.
2. Remove drain plugs (port and starboard) from cylinder block.



72993

Starboard Side Shown (Port Similar)

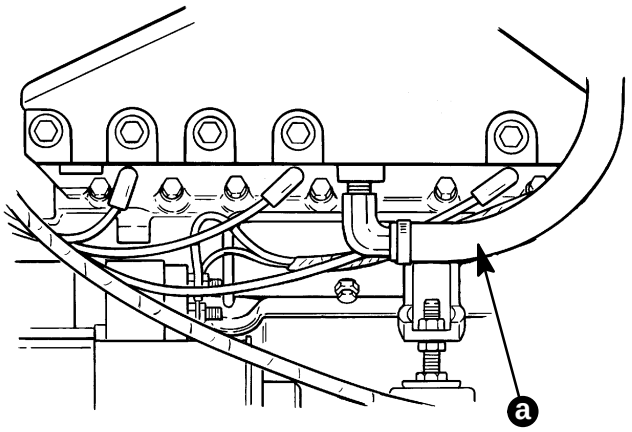
a - Drain Plug (Port and Starboard)

3. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses are disconnected.*

4. Remove hose or drain plug from bottom of port and starboard manifolds.

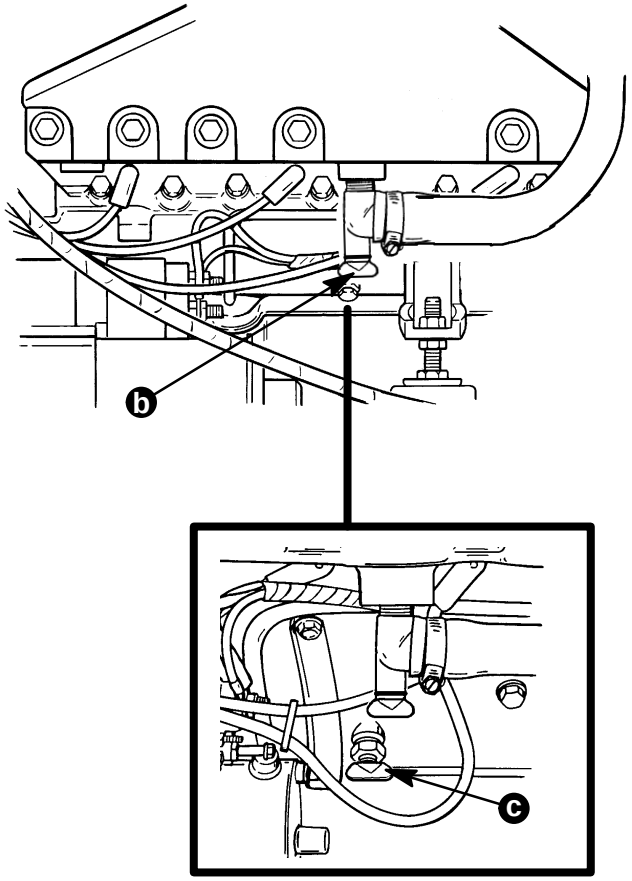
NOTE: *With the engine level, sufficient draining of manifolds will occur when exhaust manifold-to-thermostat housing hoses are removed.*



72993

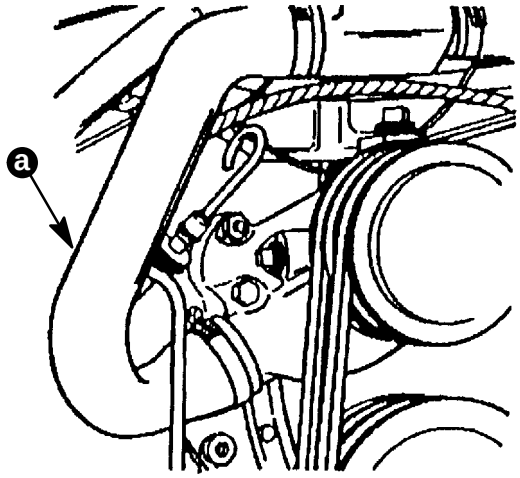
Starboard Side Shown (Port Similar)

a - Bottom Hose, Exhaust Manifold to Thermostat Housing



b - Drain Plug in Exhaust Manifold Elbow
c - Later Models Are Equipped With This Style Of Drain Plug.

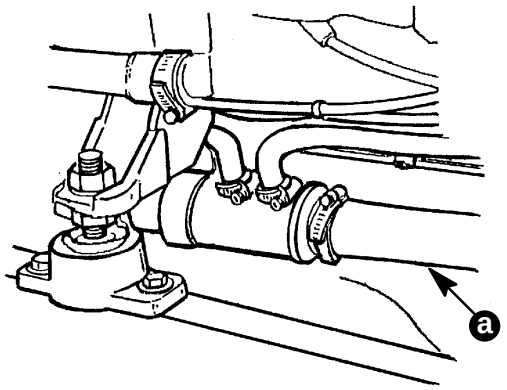
5. Remove the engine water circulating pump hose as shown.



72587

a - Hose, Water Circulating Pump to Thermostat Housing

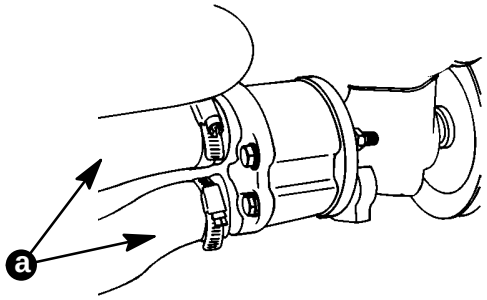
6. Remove the power steering fluid cooler seawater hose, as shown.



72588

a - Hose, Seawater Pump to Cooler

7. Bravo models need to remove both hoses form seawater pump.

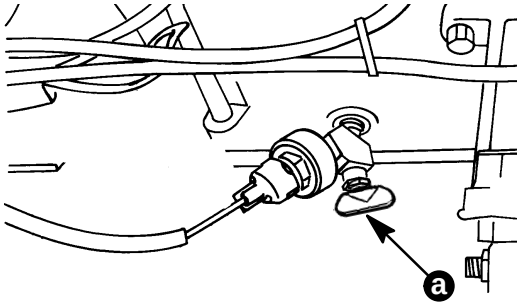


71170

a - Seawater Inlet And Outlet Hoses

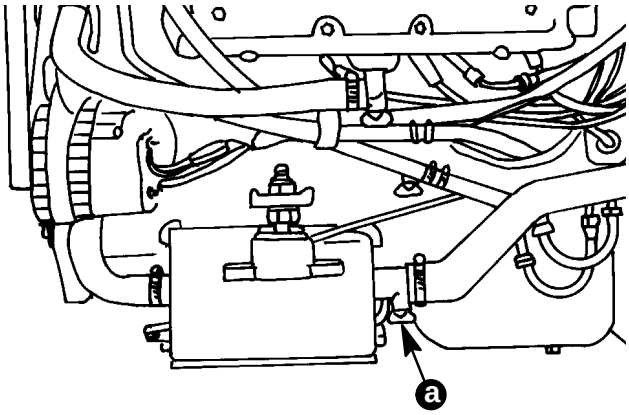
8. **For 1996 and newer models the additional following steps must be performed:**

   a. Remove the drain plug from the Y-fitting form the port side of the block.

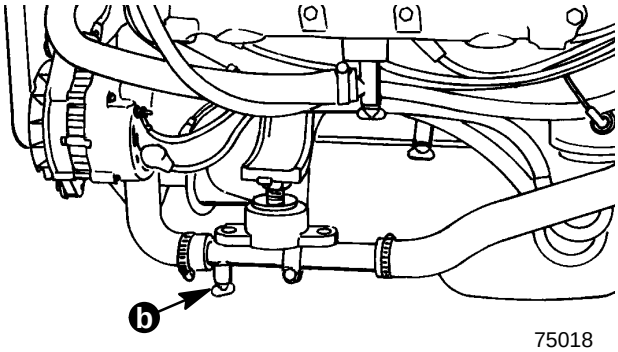


a - Drain Plug

   b. Remove the drain plug from the water tube (carburetor models) or Cool Fuel system (fuel injection models)



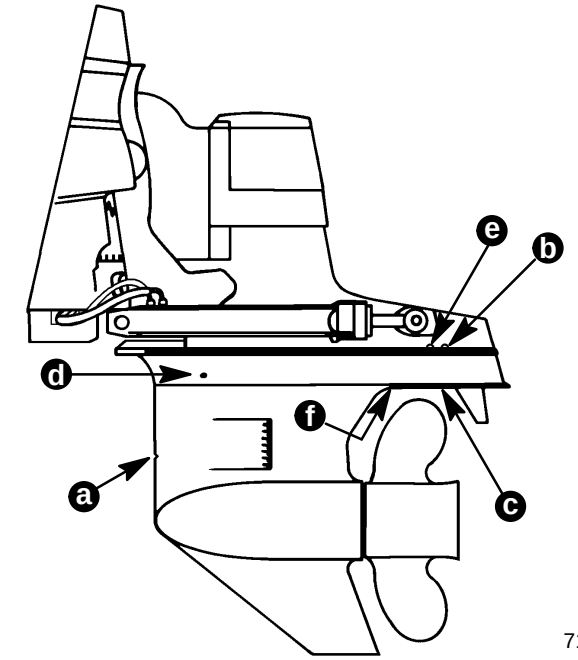
75081



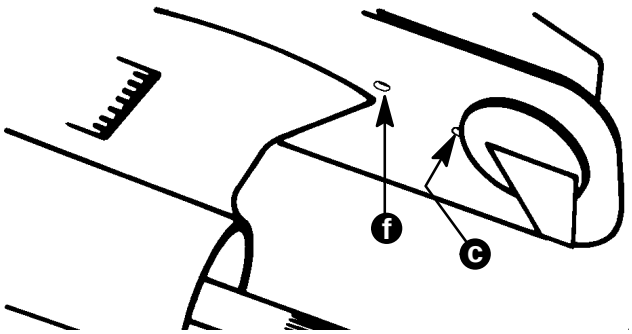
75018

a - Drain Plug (Cool Fuel System - Fuel Cool System)
b - Drain Plug (Water Tube - Carburetor Models)

9. Insert a small wire (repeatedly) to make sure that vent holes and water drain holes and passages (as shown) are unobstructed and open.



71216



70134

a - Speedometer Pitot Tube
b - Trim Tab Cavity Vent Hole
c - Trim Tab Cavity Drain Passage
d - Gear Housing Water Drain Hole (One Each - Port and Starboard
e - Gear Housing Cavity Vent Hole
f - Gear Housing Cavity Drain Hole

10. After cooling system has been drained completely, install and tighten securely all drain plugs. Reconnect all hoses and tighten all hose clamps securely.

Auxiliary Hot Water Heater Installation Information

IMPORTANT: When connecting a cabin heater or hot water heater, certain requirements must be met.

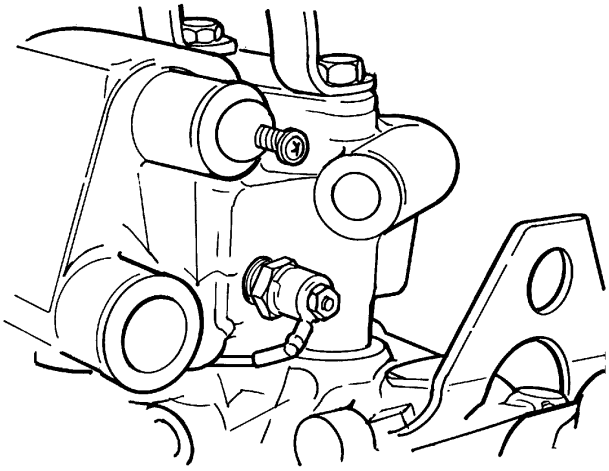
- **Supply hose (from engine to heater) and return hose (from heater to engine) MUST NOT EXCEED 5/8 in. (15.8 mm) I.D. (inside diameter).**
- **Make heater connections ONLY at locations described in the following instructions.**
- **Check complete system for leaks after heater is connected into cooling system.**
- **Check for overheating condition (of engine) after heater is connected.**

1. Hot water heater supply hose can be connected at several different locations. On some models, there may be other accessories and options that are using these hot water supply locations. One of the following should be available for use when connecting the hot water heater system.

   a. Port side of thermostat housing.

NOTE: *On some models it may be necessary to remove the audio warning heat switch from port side of thermostat housing and reposition to water circulating pump opening as outlined following.*

b. Starboard side of thermostat housing, unless being used for engine temperature switch.

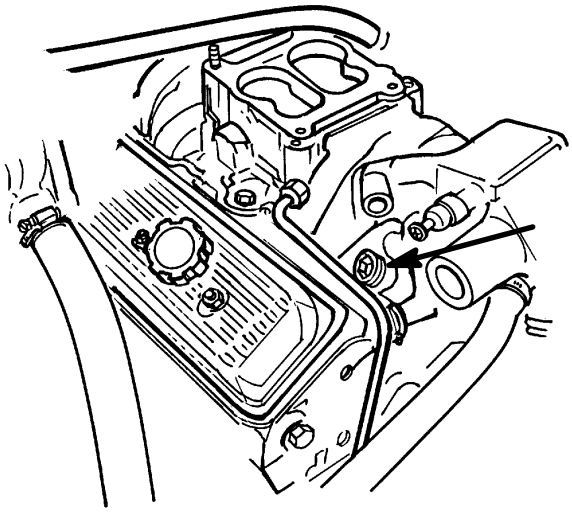


72613

Thermostat Housing - Port Side Shown (Starboard Similar)

IMPORTANT: Do not reposition engine temperature switch, it must remain where installed by factory.

c. Intake manifold near thermostat housing (some models).



72708

Intake Manifold (If Engine Temperature Sender is Not Installed at This Location)

2. Connect hot water heater SUPPLY hose to desired location following instructions “a” or “b”:

   a. **On Models with Pipe Plug in Thermostat Housing (Port or Starboard) or Intake Manifold:**

      (1) Remove pipe plug.

      (2) Coat threads of fitting(s) (obtained locally) with Quicksilver Perfect Seal and install fitting(s) in threaded hole from which pipe plug was removed.

      (3) Connect hot water heat supply hose to fitting and secure with a hose clamp (not provided).

   b. **On Models with Audio Warning Heat Switch in Thermostat Housing (Port Side):**

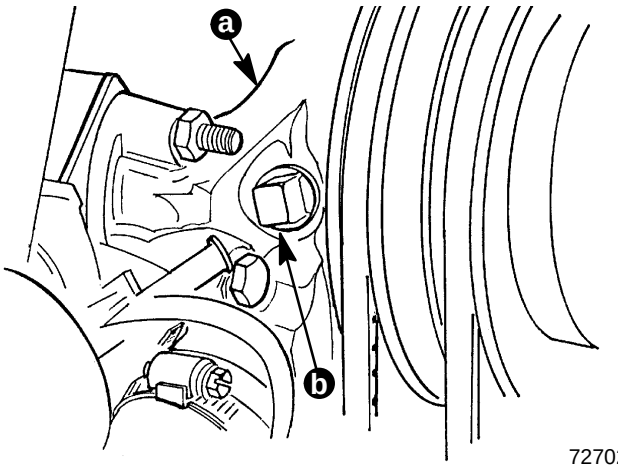
      (1) Disconnect TAN/BLUE wire from audio warning switch.

      (2) Remove audio warning switch from thermostat housing.

      (3) Coat threads of fitting(s) (obtained locally) with Quicksilver Perfect Seal and install fitting(s) in threaded hole from which audio warning switch was removed.

      (4) Connect hot water heater supply hose to fitting and secure with a hose clamp (not provided).

      (5) Remove pipe plug from starboard side of engine water circulating pump.



72702

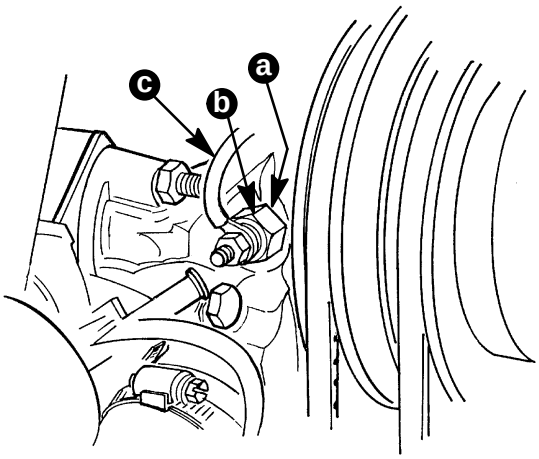
a - Engine Water Circulating Pump
b - Pipe Plug

(6) Apply Loctite Pipe Sealant with Teflon to threads of reducer bushing (obtain locally) and audio warning heat switch.

(7) Install reducer bushing in circulating pump and tighten securely.

(8) Apply Loctite Pipe Sealant with Teflon to threads of audio warning switch and install in reducer bushing. Tighten securely.

(9) Connect TAN/BLUE wire to switch and secure with nut and lockwasher. Coat terminal with Quicksilver Liquid Neoprene.

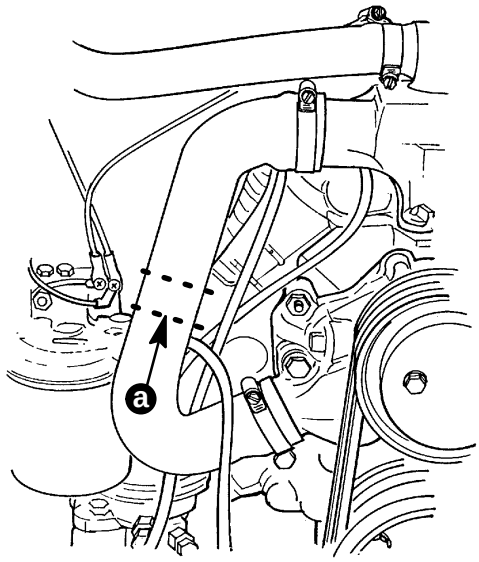


72703

a - Reducer Bushing (Hidden in this View)
b - Audio Warning Heat Switch
c - TAN/BLUE WIre

3. Connect hot water heater return hose into system as follows (refer to figures):

   a. Cut approximately 3/4 in. (19 mm) out of hose to maintain proper hose configuration.

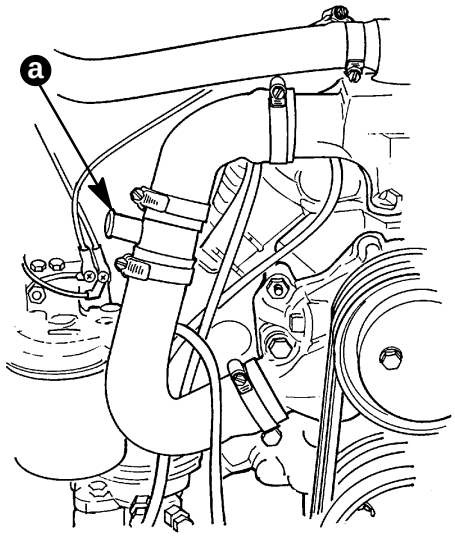


72704

Typical

a - Cut Here

   b. Secure T-fitting in hose with hose clamps (provided in kit) and tighten securely.



72705

Typical

a - T-Fitting

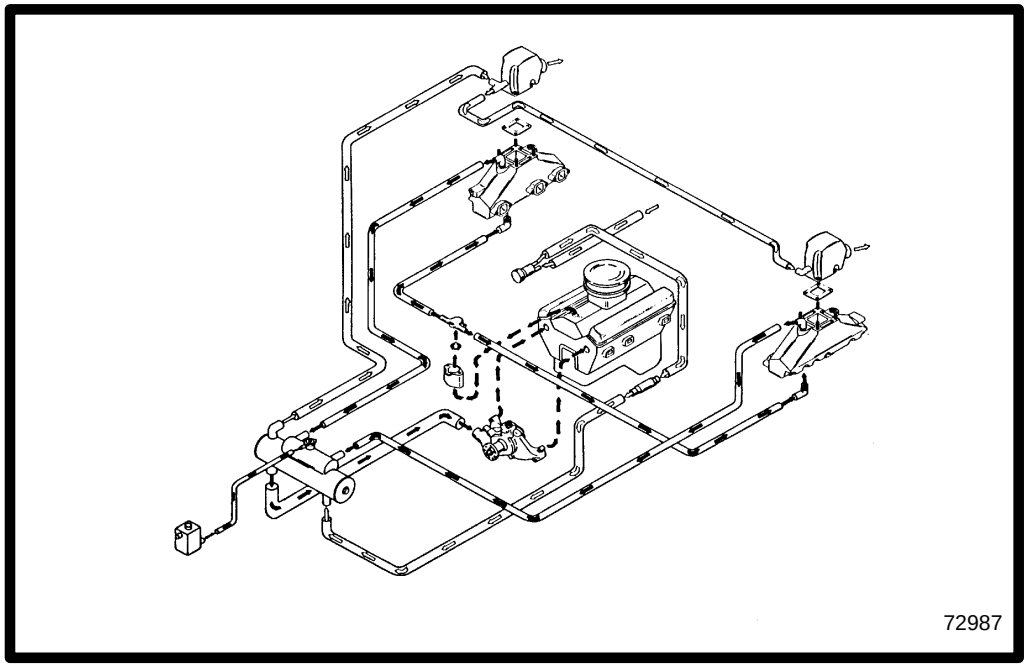
   c. Connect hot water heater return hose to T-fitting and secure with hose clamp (provided).

4. Secure hoses, as required, to ensure they do not rub or chafe against engine components.

5. With boat in water, start engine and check for leaks and overheating.

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

COOLING SYSTEM



6
B

CLOSED COOLED MODELS

Index

Table of Contents

Page

262 CID / 4.3L 6B-1
Torque Specifications 6B-1
Lubricants, Sealers And Adhesives 6B-1
Specifications 6B-1
Water Flow Diagrams 6B-2
Engines With Coolant Flow Thru Exhaust Manifolds (Excluding Gen +) 6B-2
Engines With Raw Water Flow Thru Exhaust Manifolds 6B-3
Description 6B-4
Seawater Pickup Pump (If Equipped) 6B-4
Maintenance 6B-4
Stern Drive Unit Seawater Pickup Pump . . 6B-4
Belt Driven Seawater Pickup Pump 6B-4
Output Test 6B-5
Removal 6B-6
Disassembly (Two Piece Body) 6B-8
Seawater Pump Disassembly (One Piece Body) 6B-9
Housing disassembly 6B-9
Cleaning and Inspection 6B-11
Reassembly 6B-11
Reassembly (Two Piece Body) 6B-13
Seawater Pump Reassembly (One Piece Body) 6B-14
Installation 6B-15
Closed Cooling Systems With Coolant Flow Thru Exhaust Manifolds (Excluding Engines With Serpentine Belt) 6B-17
Maintaining Coolant Level 6B-17
Pressure Cap Maintenance 6B-17
Heat Exchanger Repair 6B-18
Testing Closed Cooling System 6B-18
Testing Coolant for Alkalinity 6B-18
Pressure Testing System 6B-19
Testing for Cylinder Head Gasket Leak . . 6B-20
Testing Heat Exchanger 6B-20
Testing Pressure Cap 6B-20
Thermostat 6B-21
Removal 6B-21

Page

Flushing Seawater Section of Closed Cooling System 6B-28
Draining Seawater Section of Closed Cooling System 6B-30
Draining Precautions 6B-30
Filling Closed Cooling Section 6B-32
Closed Cooling System With Raw Water Flow Thru Exhaust Manifold (Engines With Serpentine Belt Only) 6B-33
Maintaining Closed Cooling System Coolant 6B-33
Checking Coolant for Alkalinity 6B-34
Changing Coolant 6B-34
Draining Instructions 6B-34
Filling Instructions 6B-35
Pressure Cap Maintenance 6B-37
Flushing Seawater Section 6B-38
Cleaning Seawater Section of Heat Exchanger and Fluid Coolers 6B-39
Cleaning Closed Cooling Section 6B-40
Cold Weather or Extended Storage 6B-41
Seawater Section Draining Instructions . . 6B-41
Serpentine Drive Belt Adjustment 6B-44
Auxiliary Hot Water Heater Installation . . . 6B-45
Testing 6B-23
Installation 6B-24
Changing Coolant 6B-26
Closed Cooling Section 6B-26
Coolant Recommendations 6B-26
Change Intervals 6B-26
Draining Instructions 6B-26
Cleaning System 6B-27
Closed Cooling Section 6B-27
Seawater Section 6B-27

Index

262 CID / 4.3L

TORQUE SPECIFICATIONS

DESCRIPTION	Lb. In.	Lb. Ft.	N·m
Heat Exchanger End Caps	36-72		4-8
Seawater Pump Brace		30 (41)	
Seawater Pump Bracket to Block			
Seawater Pump Cover	120	30	14
Seawater Pump Mounting Nuts to Stamped Steel Brackets			
Thermostat Cover			
Thru Hull Pickup Nut			
Drain Plugs	Securely		
Heat Exchanger Mounting Brackets			
Hose Clamps			

LUBRICANTS, SEALERS AND ADHESIVES

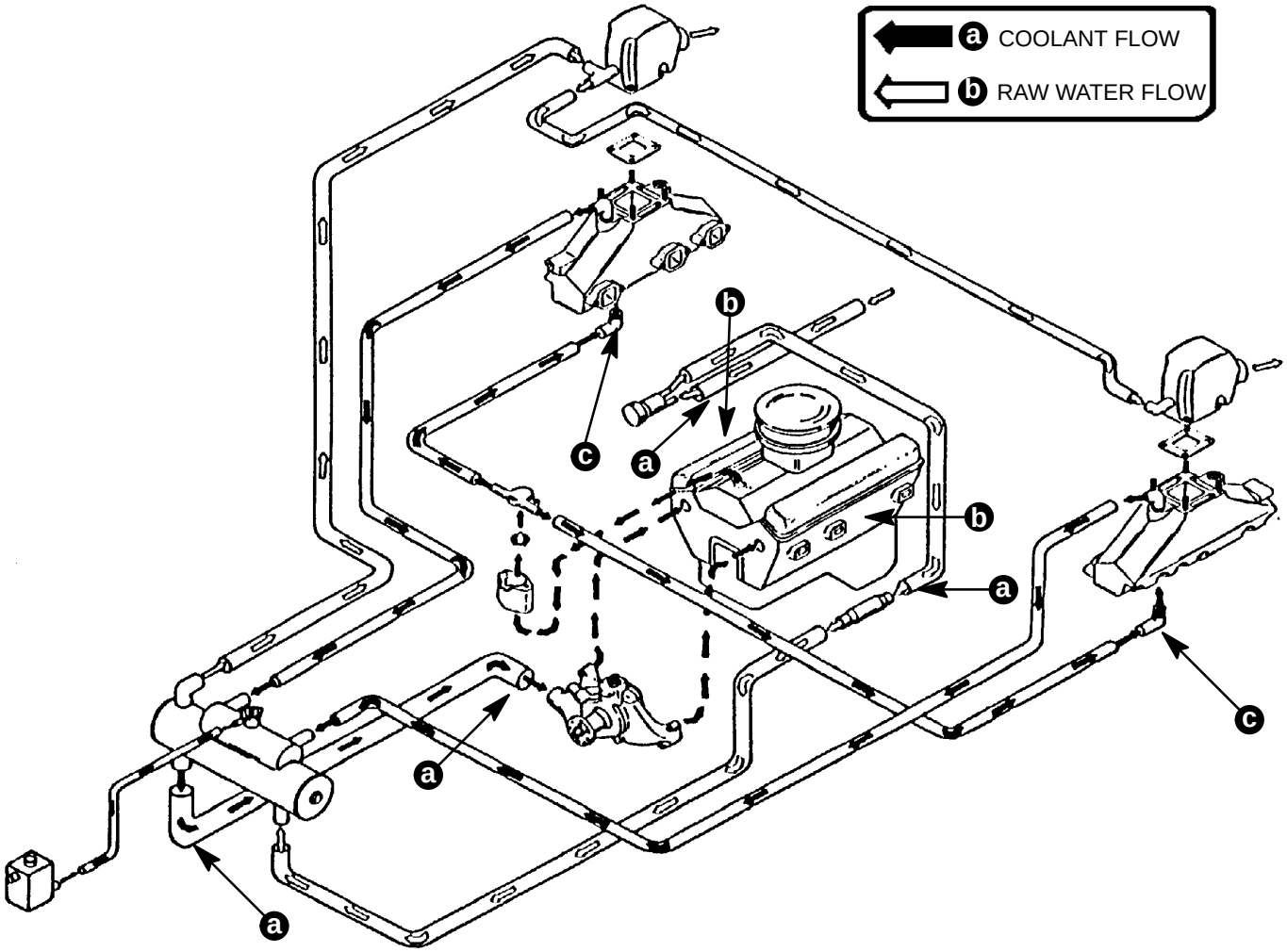
DESCRIPTION	PART NUMBER
Quicksilver 2-C-4 Marine Lubricant with Teflon	92-825407A3
Quicksilver Perfect Seal	92-34227-1
Quicksilver Liquid Neoprene	92-25711-2
Quicksilver Loctite Type 8831	92-823089-1
Loctite 514	9275505-1
Quicksilver Special Lubricant 101	92-13872A1
Loctite Pipe Sealant with Teflon	Obtain Locally

SPECIFICATIONS

Cooling System Capacity	20 (19)
Thermostat Stainless Steel	160° F (71 °C)
Thermostat Brass	140° F (67 °C)
Cap Pressure	14 PSI (97 kPa)

Water Flow Diagrams

Engines With Coolant Flow Thru Exhaust Manifolds (Excluding Gen +)

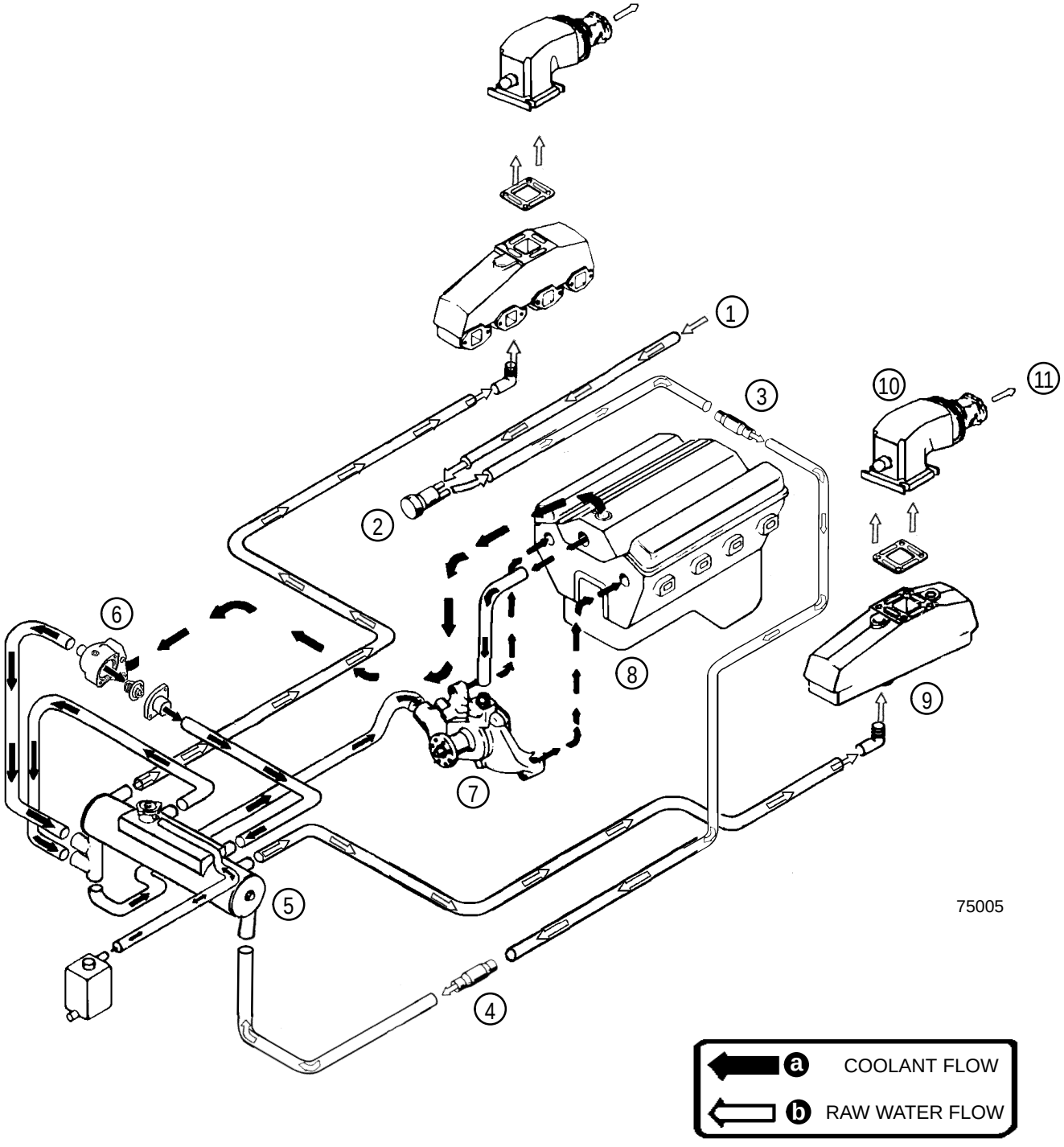


Typical Thermostat and Thermostat Housing Shown (All Similar)

a - Remove Hoses (Lift, Lower or Bend To Completely Drain).
b - Remove Block Plugs (Repeatedly Clean Out Holes Using A Stiff Wire Until Entire System Is Drained).
c - Remove Drain Plugs From Exhaust Exhaust Manifold Drain Elbows (Repeatedly Clean Out Holes Using A Stiff Wire Until Entire System Is Drained)

Index

Engines With Raw Water Flow Thru Exhaust Manifolds



a - Remove Hoses (Lift, Lower or Bend To Completely Drain).
b - Remove Block Plugs (Repeatedly Clean Out Holes Using A Stiff Wire Until Entire System Is Drained).
c - Remove Drain Plugs From Exhaust Exhaust Manifold Drain Elbows (Repeatedly Clean Out Holes Using A Stiff Wire Until Entire System Is Drained)

Index

Description

There are several configurations of this cooling system, but the operation is essentially identical. Basically, the system is composed of two separate subsystems: the seawater system and the closed cooling system. The seawater system is similar in function to the fan used in an automobile because it absorbs heat (from the closed cooling system) as it passes through the heat exchanger. The closed cooling system is similar in function to the rest of the cooling system in an automobile.

The coolant recovery system keeps the reservoir full. Normal coolant overflow into recovery bottle is approximately 1/2 pint (230 mL) during warm-up. The coolant recovery system draws coolant back into the reservoir from the recovery bottle as the engine cools. As long as there is coolant in the recovery bottle, the reservoir should remain completely full. If not, there's a vacuum leak, usually at the hose leaving the reservoir, or the gasket under the recovery filler cap. The gasket seals against the outer rim of the filler neck.

IMPORTANT: The coolant (antifreeze) flows around the outside of the cooling tubes while seawater flows through the inside of the cooling tubes in the heat exchanger.

All V-6 engine exhaust manifolds are cooled by coolant in the closed cooling system. V-6 engines operated in seawater (lakes, oceans, etc) having an ambient temperature above 80°F (26°C) may have an optional belt driven seawater pickup pump mounted on the block. Otherwise, the seawater pickup pump in the Alpha stern drive cools the stern drive, flows through the heat exchanger and is then discharged overboard.

Seawater Pickup Pump (If Equipped)

Maintenance

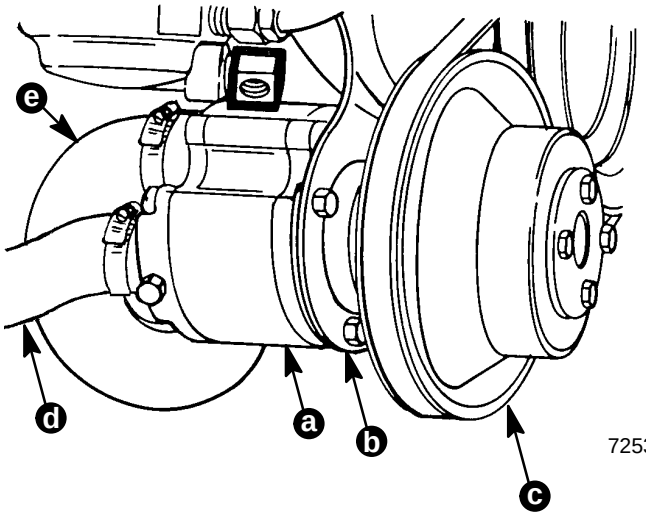
Whenever insufficient water flow is suspected, seawater pickup pump should be disassembled and inspected by an authorized MerCruiser Dealer.

Stern Drive Unit Seawater Pickup Pump

NOTICE

Refer to SECTION 6A for information and service procedures on Stern Drive Unit Seawater Pickup Pump.

Belt Driven Seawater Pickup Pump



a - Seawater PUmp
b - Bracket
c - Pulley
d - Inlet Hose
e - Outlet Hose

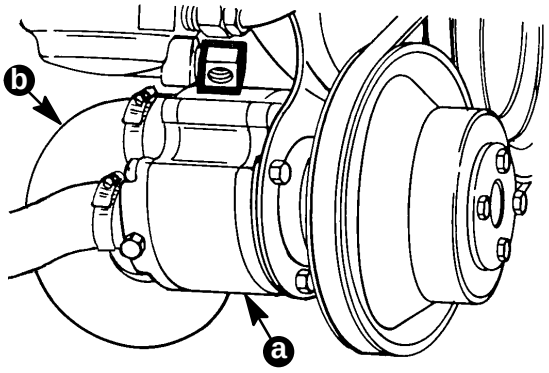
OUTPUT TEST

If an overheating problem exists, use this test to determine if a sufficient amount of water is being supplied to cool engine.

IMPORTANT: The following information should be observed before proceeding with test:

- **BOAT MUST BE IN THE WATER FOR THIS TEST. This test CANNOT be performed with a flush-test device and water hose.**
- **The ability of this test to detect a problem is greatly dependent upon the accuracy in which it is performed. An error in setting the engine RPM, timing the test or measuring the water output will affect the overall accuracy of the test and may produce misleading results. To help ensure accurate results, a shop tachometer with an error of less than 5% should be used. The boat tachometer definitely should not be used as its accuracy is questionable. A stop watch should be used to time the duration of the test to help ensure that the accuracy is maintained within one second. An 8 U.S. qt. (7.6 L) or larger capacity container should be used to measure water output.**
- **Due to the manner in which this test is performed, it may not be possible to detect a marginal condition or a high-speed water pump output problem.**

1. Remove water hose, which runs between pump outlet and engine, and replace with another hose of same diameter, but approximately 3 ft. (1 m) longer. Hose should be wire reinforced or of adequate wall thickness to prevent it from kinking when performing test. Clamp hose at pump outlet only. Do not clamp hose at engine end.



72532

a - Seawater Pickup Pump
b - Seawater Outlet Hose

2. Place an 8 U.S. qt. (7.6 L) or larger container near unclamped end of hose.

⚠CAUTION

Do not run engine for more than 15 seconds with hose disconnected, in next step, as internal damage to engine and exhaust system may result.

3. With assistance of another person, start engine and adjust speed to exactly 1000 RPM while holding unclamped end of hose on connection on engine. Remove hose from connection on engine and direct water flow into container for exactly 15 seconds. At the end of 15 seconds, direct the water flow overboard, return engine to idle and stop engine. Reconnect hose to engine.
4. Measure quantity of water discharged into container and compare with specifications given in chart following.
5. Repeat test four times to check repeatability of results.

Belt Driven Pump Output for 15 Second Period
7.5 U.S. Qts. (7.1 L) Minimum

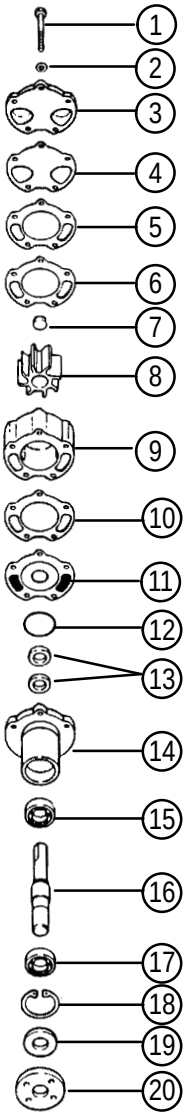
REMOVAL

⚠CAUTION

If boat is in the water, be sure to close seacock before removing inlet hose from pump to prevent water from draining into boat. If boat is not fitted with a seacock, disconnect and plug seawater inlet hose after removing.

IMPORTANT: The following procedure describes removal of both pump and mounting bracket from engine. On some installations, however, it may be possible to remove pump with mounting bracket left installed on engine.

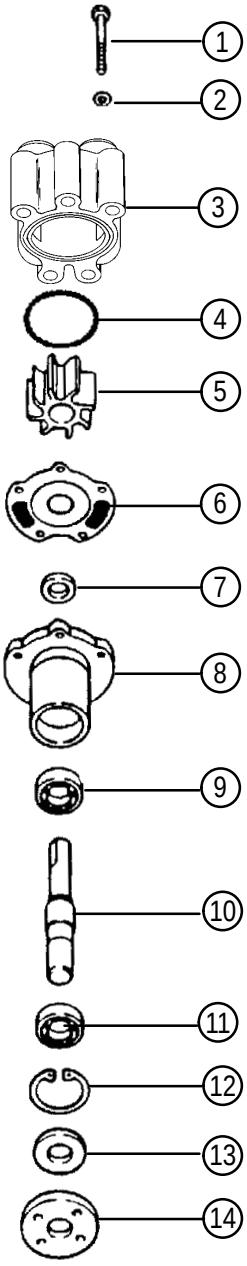
1. Close seacock, if so equipped, or disconnect and plug seawater inlet hose.
2. Disconnect water inlet and outlet hoses from pump.
3. If pump is to be disassembled, loosen the four pump pulley attaching screws. Do not remove screws at this time.
4. Remove power steering pump drive belt to allow removal of seawater pickup pump drive belt.
5. Remove pulley attaching screws, then remove pulley.
6. Remove attaching hardware which secures pump brace to cylinder block.
7. Remove pump mounting bracket-to-cylinder block attaching hardware and remove pump, mounting bracket and brace as an assembly.
8. Remove fasteners securing bracket and brace to pump and remove both from pump body.



72646

Two Piece Pump Assembly

1 - Screw (5)
2 - Washer (5)
3 - Cover
4 - Gasket
5 - Wear Plate (Outer)
6 - Gasket
7 - Plug
8 - Impeller
9 - Body
10- Gasket
11- Wear Plate (Inner)
12- O-Ring or Quad Ring
13- Oil Seal
14- Housing
15- Ball Bearing
16- Shaft
17- Ball Bearing
18- Snap Ring
19- Oil Seal
20- Hub



74577

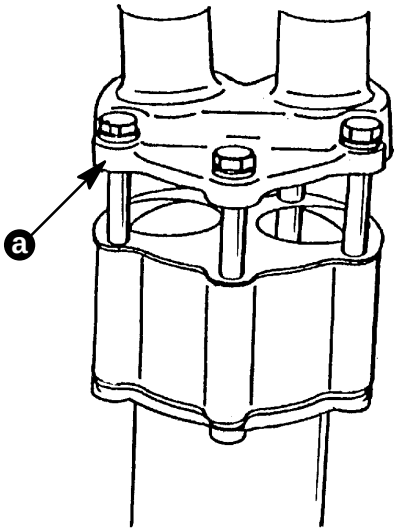
One Piece Pump Assembly

1 - Screw (5)
2 - Washer (5)
3 - One Piece Body
4 - Quad Ring
5 - Impeller
6 - Wear Plate
7 - Oil Seal
8 - Housing
9 - Ball Bearing
10- Shaft
11- Ball Bearing
12- Snap Ring
13- Oil Seal
14- Hub

Index

DISASSEMBLY (TWO PIECE BODY)

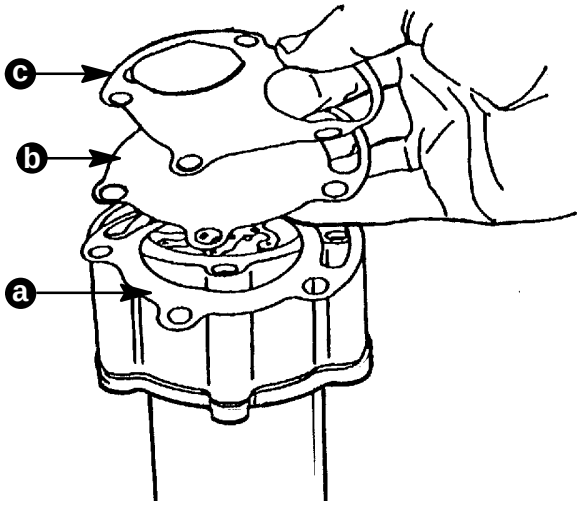
1. Remove cover and body attaching screws and washers.



72650

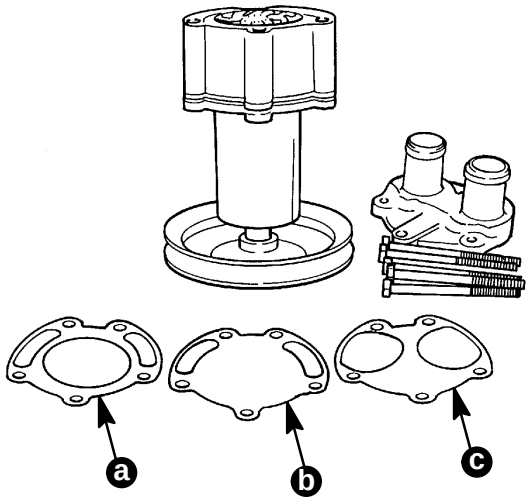
a - Cover

2. Remove gasket, outer wear plate and gasket (discard gaskets).



72651

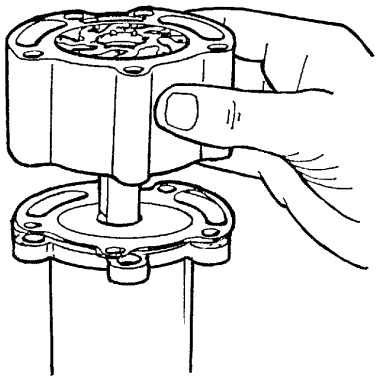
a - Gasket (with Large Opening)
b - Wear Plate (Outer)
c - Gasket (with Two Openings)



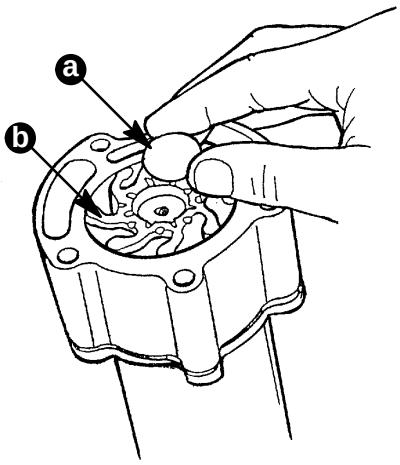
72652

a - Gasket (with Large Opening)
b - Wear Plate (Outer)
c - Gasket (with Two Openings)

3. Slide pump body off shaft. Remove impeller from pump body and rubber plug from impeller.



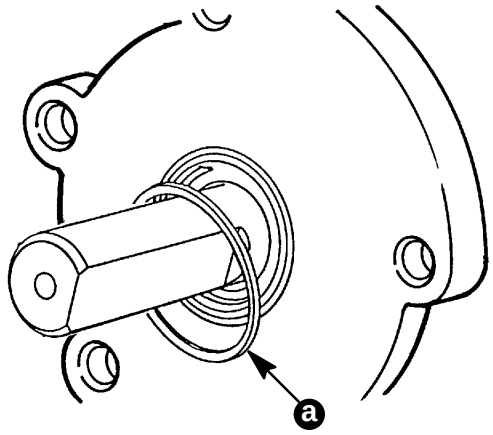
72653



72654

a - Rubber Plug
b - Impeller

Index

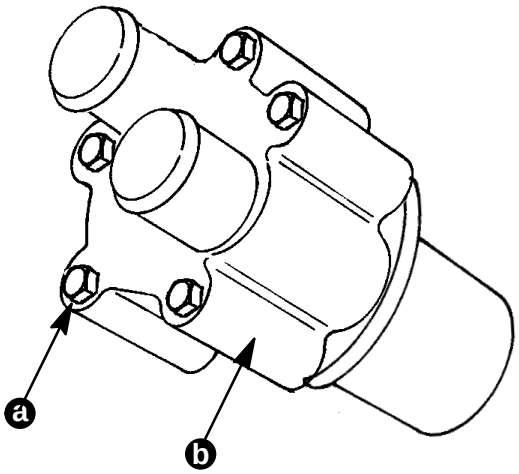


72656

a - Quad Ring Seal

SEAWATER PUMP DISASSEMBLY (ONE PIECE BODY)

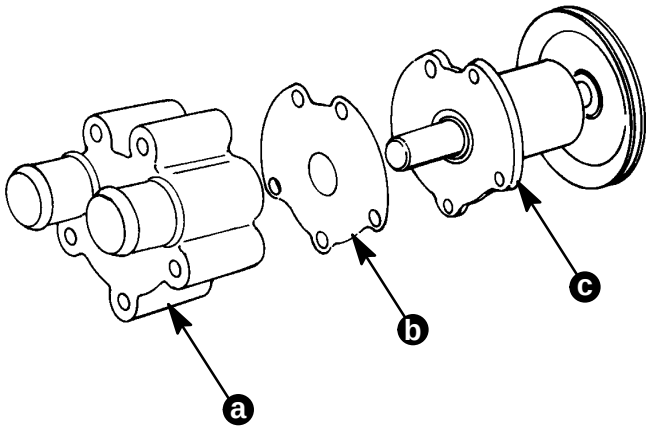
1. Remove the five screws from the seawater pump body.



75277

a - Screws (5)
b - Seawater Pump Body

2. Remove seawater pump body and wear plate from bearing housing.



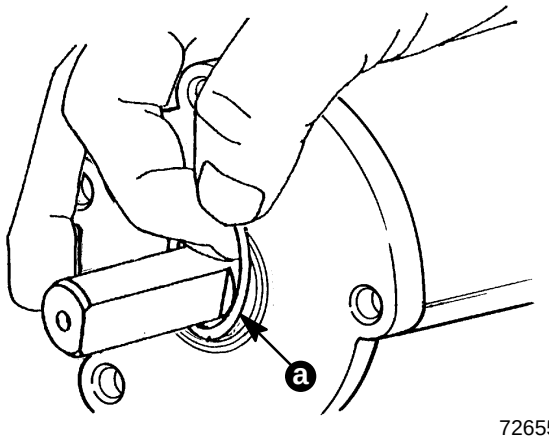
75275

a - Seawater Pump Body
b - Wear Plate
c - Bearing Housing

3. Remove the impeller from seawater pump body.

HOUSING DISASSEMBLY

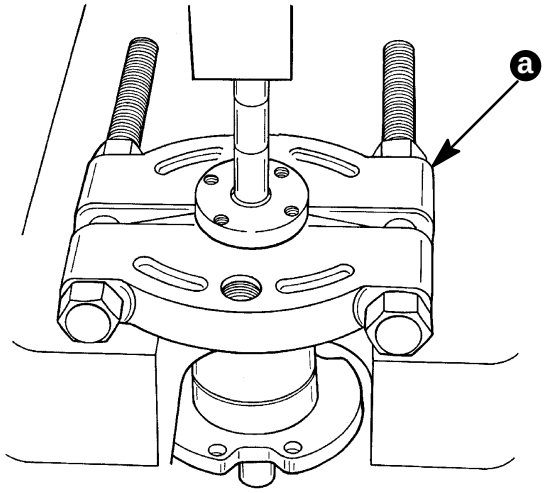
4. Remove gasket, inner wear plate and quad ring seal. Discard gasket and quad ring seal.



72655

a - Quad Ring Seal

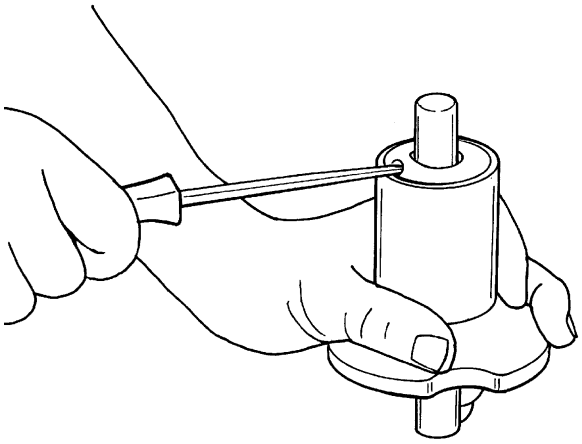
5. Press hub off shaft with Universal Puller Plate and an arbor press.



72648

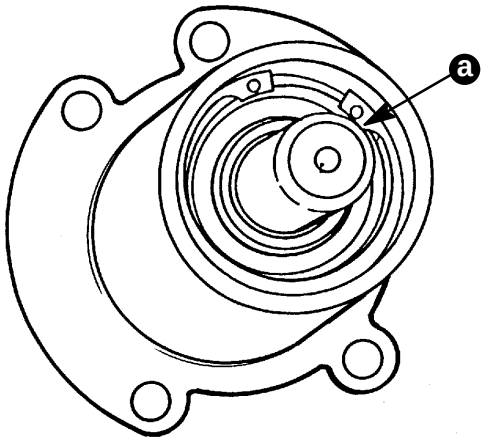
a - Universal Puller Plate (91-37241)

6. Puncture front oil seal with a tool and pry from bearing housing.

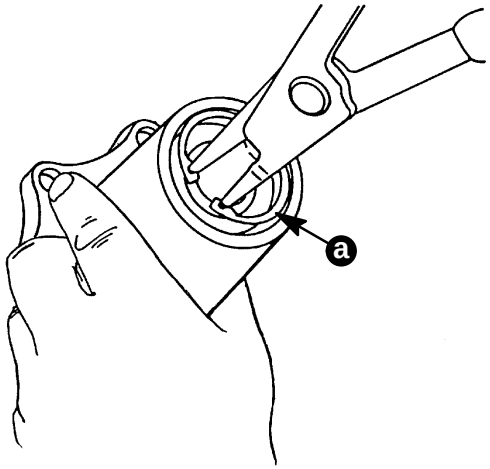


72649

7. Remove snap ring from bearing housing bore and press shaft and bearings out pulley end of housing. Bearings have a slip fit in housing; do not use excessive force.



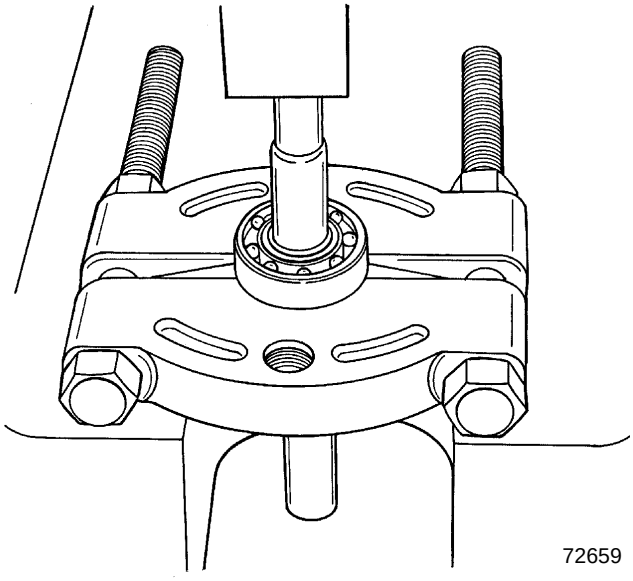
72657



72658

a - Snap Ring

8. If bearings require replacement, remove bearings from shaft with Universal Puller Plate and an arbor press. Bearings must be replaced, if removed.



9. If rear seals require replacement, press seals from bearing housing with an appropriate tool.

CLEANING AND INSPECTION

1. Clean metal parts in solvent and blow dry with compressed air.

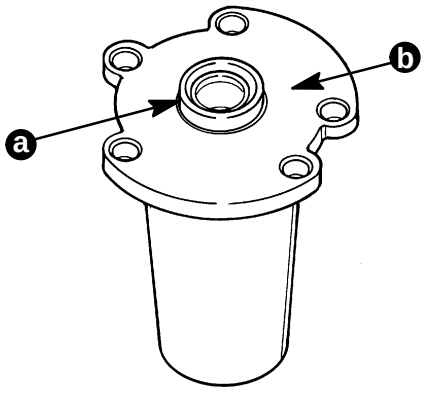
IMPORTANT: Do not spin bearings at high speed when drying with compressed air, as bearings may be scored.

2. After cleaning, apply a coat of light engine oil to shaft and bearings to prevent rust.
3. Clean all gasket material and sealer from sealing surfaces.
4. Inspect bearing housing. Examine surfaces (where bearings contact housing) for evidence of bearing outer races turning in housing.
5. Inspect seals in bearing housing.
6. Inspect pump shaft bearings.
7. Inspect pump shaft for grooves in surface where seals contact shaft. Also inspect surface where bearings contact shaft for evidence of inner races turning on shaft.
8. Inspect pump body.
9. Inspect inner and outer wear plate.
10. Inspect pump impeller for wear on sides and tips of blades. Also inspect blades for cracks in area where blades flex. Replace impeller if blades have taken a set (remain in curved position).
11. Inspect pump pulley.
12. Check drive belt for excessive wear.

REASSEMBLY

Refer to exploded view also.

1. Apply a thin coat of Quicksilver Loctite 8831 to outside diameter of two new bearing housing rear seals; then install seals in housing with seal lips facing impeller end. (Press first seal in until it bottoms out and second seal in until flush with housing.)

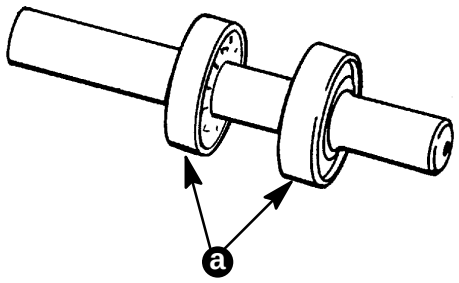


a - Outer (Water)Seal
b - Face of Housing

IMPORTANT: It is recommended that Shell Alvania No. 2 Grease be used when packing seal and bearings in the following steps. If Shell Alvania No. 2 Grease is not available, it is permissible to use Quicksilver 2-4-C Marine Lubricant. With Teflon However, Quicksilver 2-4-C Marine Lubricant With Teflon is not recommended for applications where continuous high speed heavy-duty operation will be encountered.

2. Pack cavity between seals with Shell Alvania No. 2 Grease or substitute.

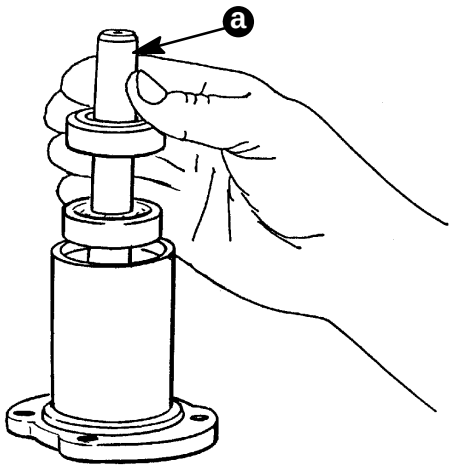
3. Using an arbor press and suitable tool, press ball bearings onto shaft until they seat. Press on inner race of bearing only.



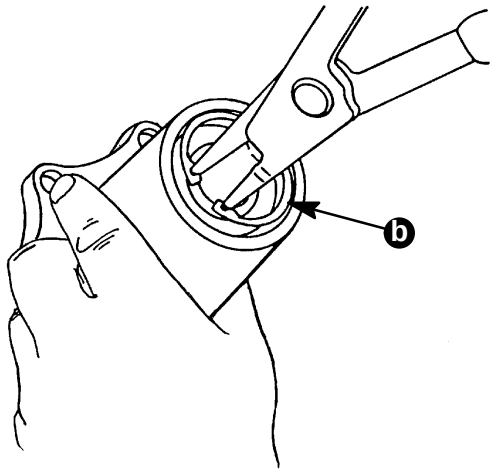
72663

a - Bearings

4. Pack bearings and cavity between bearings with Shell Alvania No. 2 Grease or substitute. Slide bearings and shaft into bearing housing bore and install snap ring.



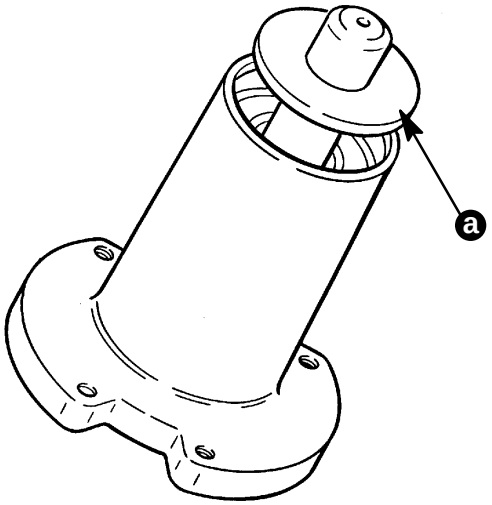
72661



72658

a - Shaft with Bearings
b - Snap Ring

5. Apply a thin coat of Quicksilver Loctite 8831 to outside diameter of new bearing housing front oil seal and press seal into housing (with seal lip facing inward) until it bottoms out.

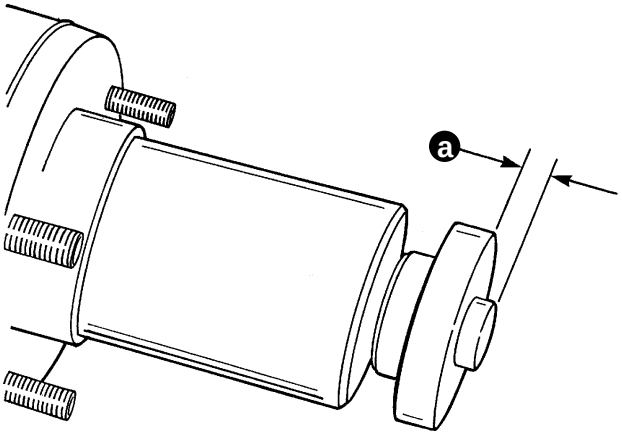


72662

a - Front Oil Seal

IMPORTANT: Be sure to support impeller end of pump shaft when installing pulley hub in next step to prevent placing a load on bearings.

6. Apply Quicksilver Special Lubricant 101 to pump shaft. Using an arbor press and appropriate tool, press pulley hub onto pump shaft to dimension shown.

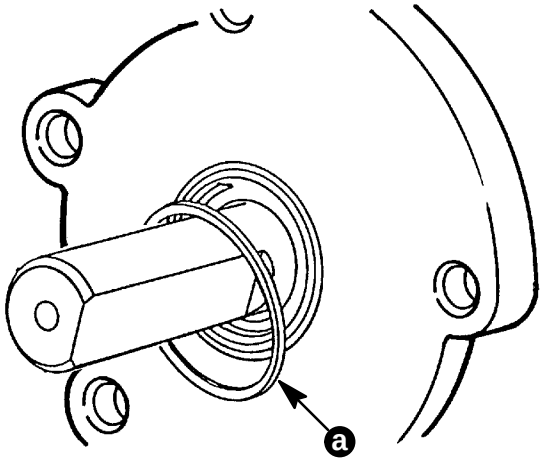


72664

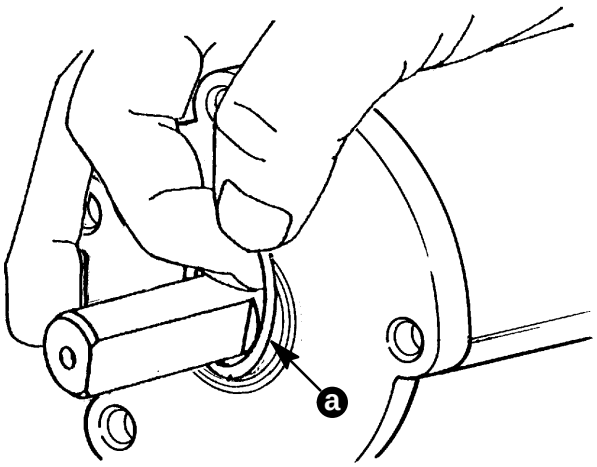
a - 17/64 In. 6.5mm)

IMPORTANT: Pulley hub must be pressed onto shaft to exact dimension on pumps with stamped steel mounting bracket as this establishes proper drive belt alignment.

7. Clamp bearing housing in a soft jaw vise with flange end up.
8. Coat quad ring seal with Quicksilver 2-4-C Marine Lubricant With Teflon and install into groove in housing.



72656

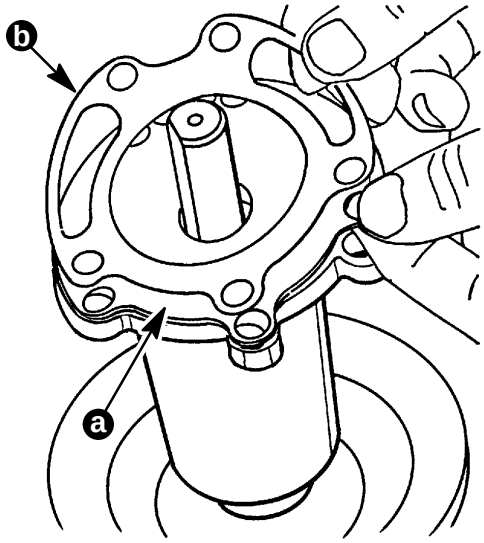


72655

a - Quad Ring Seal

REASSEMBLY (TWO PIECE BODY)

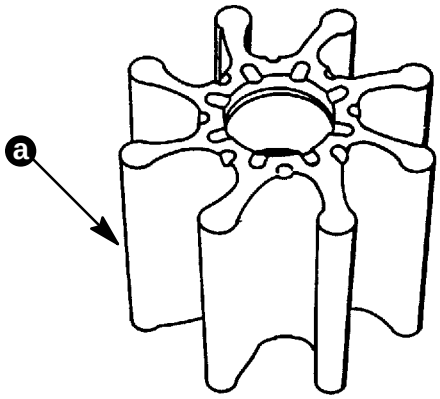
9. Place inner wear plate on housing and align holes. Coat both sides of a new wear plate gasket with a thin film of Quicksilver Perfect Seal and position on wear plate.



72665

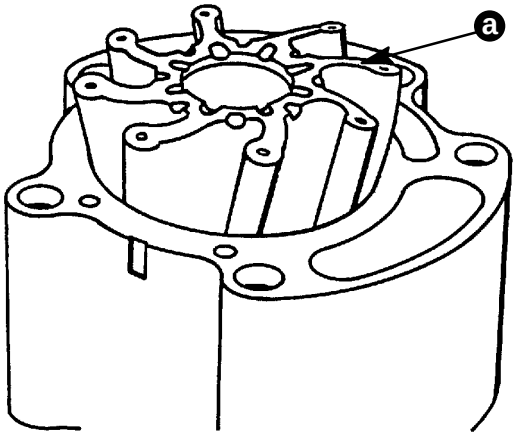
a - Wear Plate
b - Gasket

10. Install impeller into pump body by turning impeller in direction that it will be turning in operation, while simultaneously pushing inward. All impeller blades must face in same direction.



71118

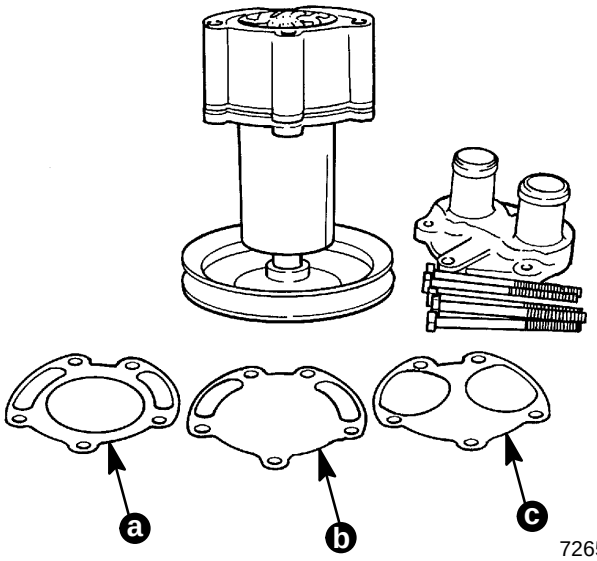
a - Impeller Blade



71150

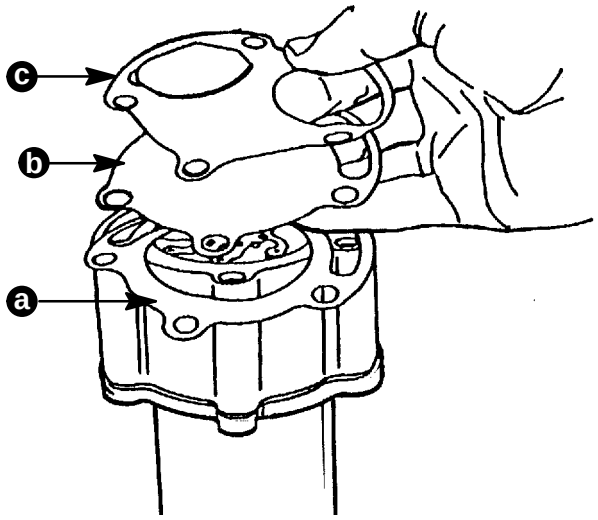
a - Impeller

11. Slide impeller and pump body assembly onto shaft. Position pump body so that holes align with holes in wear plate, gasket and bearing housing. Install rubber plug into end of impeller.
12. Coat both sides of new cover gasket and wear plate gasket with a thin film of Quicksilver Perfect Seal. Install outer wear plate with new gaskets on each side, aligning holes in plate and gaskets with holes in pump body.



72652

a - Gasket (with Large Opening)
b - Wear Plate (Outer)
c - Gasket (with Two Openings)



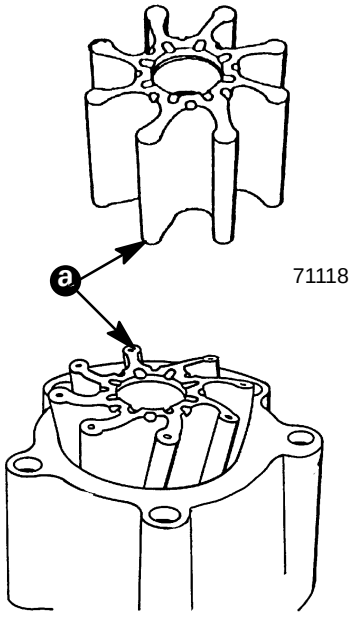
72651

a - Gasket (with Large Opening)
b - Wear Plate (Outer)
c - Gasket (with Two Openings)

13. Install pump cover and secure with five bolts and washers. Torque bolts to specifications.

SEAWATER PUMP REASSEMBLY (ONE PIECE BODY)

1. Lubricate seawater pump impeller with a water and soap solution. Install impeller into housing by rotating and pushing it into place. Push it down until flush with housing.

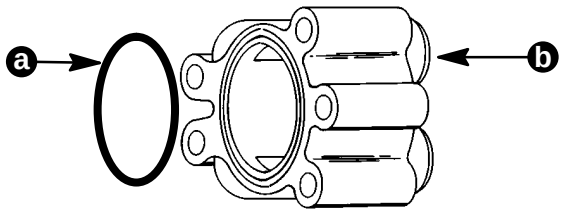


71118

71150

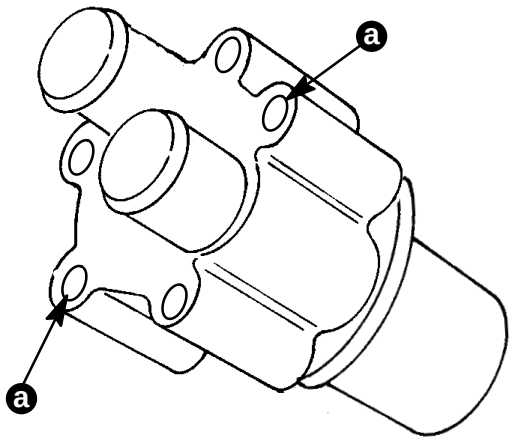
a - Impeller

2. Place wear plate over bearing housing shaft.
3. Place quad ring in groove in seawater pump body.



a - Quad Ring
b - Seawater Pump

4. Align flats on impeller and bearing housing shaft, slide seawater pump body on shaft.
5. Install two screws in seawater pump body holes as shown. Use these two screws to align pump, then install the remaining screws.



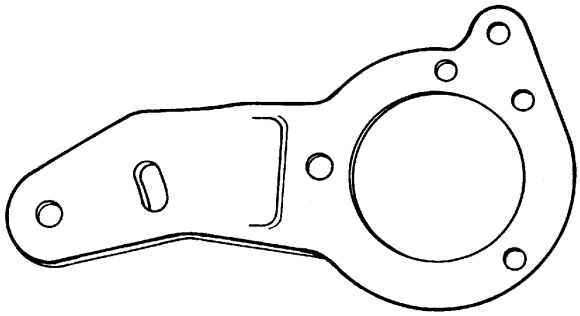
75277

a - Bolt Holes For Alignment

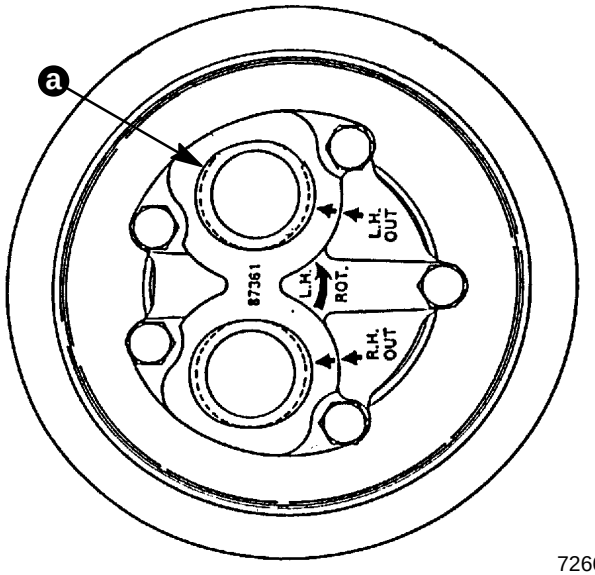
INSTALLATION

1. Position pump in mounting bracket so that outlet connection will be directly above inlet connection when pump is installed.

IMPORTANT: Pump must be positioned correctly or overheating of engine may occur.



72666



72667

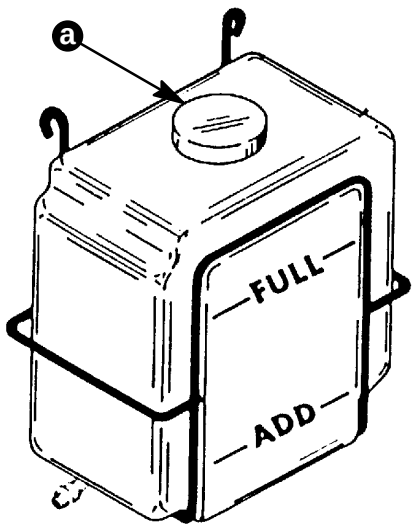
a - LH Out - At Top

IMPORTANT: Flat washer must be installed between mounting bracket clamping bosses or damage to pump may result (if clamping screw is over-tightened).

2. Install pulley on pump and secure with four screws, lockwashers and clamping ring (some models). Tighten screws finger-tight only at this time.
3. Attach pump, mounting bracket and brace assembly to engine. Do no tighten attaching screws at this time.
4. Torque pump pulley attaching screws.
5. Position drive belt on pulleys and adjust belt tension as outlined in “Drive Belt Tension Adjustment.”
6. Connect seawater inlet hose to lower fitting on pump.
7. Connect outlet hose to upper fitting on pump.
8. Tighten hose clamps securely.
9. If applicable, reinstall power steering drive belt. Adjust tension as outlined in “Drive Belt Tension Adjustment.”

Closed Cooling Systems With Coolant Flow Thru Exhaust Manifolds (Excluding Engines With Serpentine Belt)

Maintaining Coolant Level



72520

Coolant Recovery Bottle

a - Fill Cap

Before starting engine each day, check to ensure that coolant is visible in coolant recovery bottle.

If coolant is not visible, check fresh water section of cooling system (including coolant recovery system) for leaks and repair, as necessary. Refill fresh water section with recommended coolant solution, as outlined under “Changing Coolant,” following.

If coolant is visible, start engine and run until it reaches normal operating temperature, then recheck coolant level in coolant recovery bottle. Coolant level MUST BE between the ADD and FULL marks (on front of bottle).

⚠WARNING

Allow engine to cool before removing pressure cap, as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

If level is low, remove fill cap from coolant recovery bottle and add required amount of coolant solution. Use a 50/50 mixture of ethylene glycol antifreeze and pure, soft water for coolant additions. If frequent additions of coolant are required, check fresh water section for leaks.

IMPORTANT: ALCOHOL OR METHANOL BASE ANTIFREEZE OR PLAIN WATER ARE NOT RECOMMENDED FOR USE IN COOLING SYSTEM AT ANY TIME. In areas where ethylene glycol is not available, and the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and pure, soft water (mixed to manufacturer’s recommendations).

Occasionally, check to ensure that coolant recovery system is functioning properly by removing pressure cap from heat exchanger and checking level. Coolant level should be up to bottom of heat exchanger filler neck. If low, examine entire fresh water section (especially coolant recovery system) for leaks and repair, if necessary.

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts stops on filler neck.

Pressure Cap Maintenance

Pressure cap is designed to maintain pressure in fresh water section of closed cooling system once the engine has attained normal operating temperature. This raises the boiling point of the coolant, thereby increasing the efficiency of the cooling system. To help ensure proper operation, cap should be cleaned, inspected and pressure tested periodically as follows:

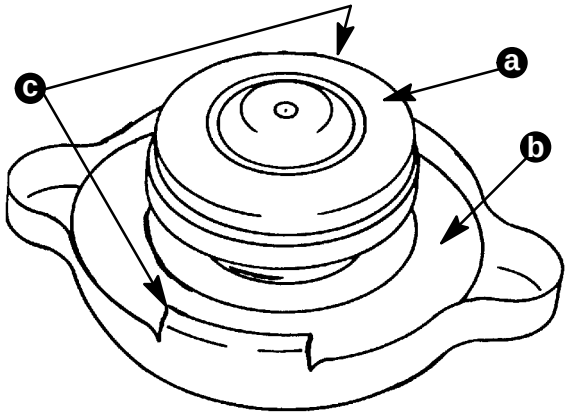
⚠WARNING

Allow engine to cool before removing pressure cap (in next step), as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

10. Remove pressure cap from heat exchanger.
11. Wash cap with clean water to remove any deposits or debris from sealing surfaces.
12. Inspect rubber seal on cap for cuts, cracks or other signs of deterioration. If seal is damaged, cap MUST BE replaced.
13. Inspect coolant recovery gasket for deterioration and replace if bad.

Index

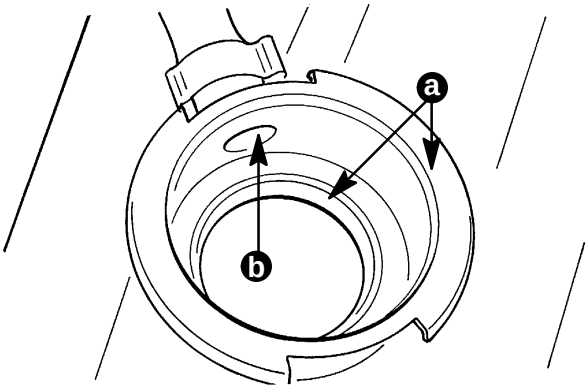
14. Check condition of locking tabs on cap. Replace cap if tabs are bent or cracked.



72714

a - Rubber Seal (Cap MUST BE Replaced if Damaged)
b - Gasket (Look for Cracks Under Gasket)
c - Locking Tabs (1 Hidden)

15. Refer to “Testing Pressure Cap” and test pressure cap as outlined.
16. Clean sealing surfaces on heat exchanger filler neck with a cloth. Inspect surfaces for any damage or deposits that may prevent cap from sealing properly.
17. Clean coolant recovery passage in heat exchanger filler neck with a wire and blow out with compressed
air.



72715

a - Inspect for Damage
b - Clean Coolant Recovery Passages

18. Reinstall pressure cap, being sure to tighten until it contacts stops on filler neck.

Heat Exchanger Repair

IMPORTANT: Braze with BCUP 2 rod or silver solder. Care must be taken not to melt other joints during repair.

1. Internal leaks can be repaired by brazing shut the ends of the leaking tube. This is only a temporary fix because usually another tube will start leaking after a short period of time and this also causes a reduction in cooling capacity. Do not close more than three tubes.
2. Nipples and drains that have been broken off the heat exchanger can be reattached by brazing.

Testing Closed Cooling System

Testing Coolant for Alkalinity

⚠WARNING

Allow engine to cool before removing pressure cap as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

Coolant in fresh water section should be changed every two years and should be checked for alkalinity at least once between change intervals. To check coolant for alkalinity, proceed as follows:

1. Obtain pink litmus paper from a local supplier (drug store, pet shop, etc.).
2. Remove pressure cap from heat exchanger and insert one end of litmus paper into coolant.
3. **If pink litmus paper turns blue,** coolant is alkaline and need not be replaced.
4. **If pink litmus paper remains pink,** coolant is not alkaline and MUST BE REPLACED, as explained under “Changing Coolant.”

Index

Pressure Testing System

⚠ WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

If coolant section of closed cooling system is suspected of leaking or not holding sufficient pressure, and no visible signs of leakage can be found, perform the following test:

1. Remove pressure cap from heat exchanger or reservoir.
2. Clean, inspect and pressure test pressure cap, as outlined under “Testing Pressure Cap,” to eliminate the possibility that cap is not maintaining proper pressure in system and is causing coolant to boil over.
3. Clean inside of filler neck to remove any deposits or debris. Examine lower inside sealing surface for nicks or other damage. Surface must be perfectly smooth to achieve a good seal between it and rubber seal on cap. Also check locking cams on sides of filler neck to be sure that they are not bent or damaged. If locking cams are bent or damaged, pressure cap will not hold the proper pressure.
4. Adjust coolant level in fresh water section to 1 in. (25 mm) below filler neck.
5. Attach an automotive-type cooling system pressure tester to filler neck and pressurize closed cooling section to amount specified in following chart, based on pressure cap rating for your engine.

Pressure Cap Rating	Amount Of Pressure Applied To Closed Cooling System
14 PSI (97 kPa)	17 PSI (117 kPa)

6. Observe gauge reading for approximately two minutes; pressure should not drop during this time. If pressure drops, proceed with the following steps until leakage is found.
7. While maintaining specified pressure on closed cooling section, visually inspect external portion of cooling system (hoses, gaskets, drain plugs, petcocks, core plugs, circulating pump seal, etc.) for leakage. Also listen closely for bubbling or hissing, as they usually are a sure indication of a leak.
8. Refer to “Testing Heat Exchanger” in this section and test as outlined.
9. If no leakage could be found in above steps, engine is leaking internally, and it probably is due to one or more of the following: (1) loose cylinder head bolts or damaged gasket, (2) loose intake manifold bolts or damaged gasket, (3) loose exhaust elbow or distribution block retaining nuts or damaged gasket, (4) cracked or porous cylinder head or block, or (5) cracked or porous exhaust manifold. Proceed as follows until location of internal leak is found.
   a. Start engine. Repressurize system to previously specified amount and observe pressure gauge on tester. If needle in gauge vibrates, compression or combustion is leaking into closed cooling section from a leak in the combustion chamber. Exact cylinders, where leakage is taking place, sometimes can be found by removing spark plug wires (one at a time) while observing pressure gauge. Vibration will decrease or stop when plug wire is removed from leaking cylinder. Stop engine.
   b. Remove spark plugs (one at a time) from cylinders and examine for presence of coolant. A spark plug that is perfectly clean or milky appearing is a sure indication of a leak.
   c. Drain oil from engine and examine for presence of coolant. Oil usually will be milky if coolant is present. If coolant is present, remove engine from boat and drop the oil pan. With engine in the upright position, repressurize closed cooling section to previously specified amount and examine internal surfaces of engine to locate leak.
   d. If no leakage can be found in above steps, entire engine must be disassembled and inspected for leakage.

Testing for Cylinder Head Gasket Leak

A leaking head gasket will cause combustion gas to be forced into the cooling system. The mixture of coolant and tiny air bubbles is a poor heat conductor and will overheat an engine quickly. Compression tests or cooling system pressure check normally will not detect the leak because the test pressure is far below the combustion pressures which cause the leak. An effective test is as follows:

IMPORTANT: Run boat in lake for this test. It is best to run the engine at or above cruising speed during this test. Usually a failed head gasket will not cause the engine to overheat below cruising speed.

1. Install a clear plastic hose between the reservoir and coolant recovery bottle. Use a 2-3 ft. (61-91 cm) long hose for this test.
2. Route this hose so a “U” is formed.
3. Put enough coolant into hose to fill the center 4 or 5 inches (10-13 cm) of the “U.”
4. Observe the “U” while the engine is running.
   a. **During Idle and Warm-Up:** Some coolant and/or air will leave the reservoir.
   b. **During Cruising Speed (2500-3500 RPM):** Coolant and/or air leaving the reservoir should stop after approximately five minutes running at a given RPM. A leaking head gasket will produce air bubbling through the “U,” going to the coolant recovery bottle. The frequency and size of the bubbles will depend on the size of the leak.
   c. **At Higher Speeds (4000+ RPM):** Normal operation is the same as described in “b” above. A failed head gasket will cause the bubbles to come faster and may be accompanied by violent, intermittent bursts of coolant.

It is important not to confuse normal warm-up expansion with a failed head gasket. Normal warm-up produces an intermittent flow of coolant which will stop within approximately five minutes at a given RPM. A head gasket leak will not stop because the one thing that marks a failed head gasket is the continued passage of air. This may be accompanied by violent, intermittent bursts of coolant leaving the reservoir. If coolant continues to flow (not in violent, intermittent bursts) from the reservoir at cruising speed, something else besides the head gasket is causing the engine to overheat.

Testing Heat Exchanger

FOR INTERNAL LEAK: An internal leak will cause coolant to go into the seawater circuit when pressure is put on the closed cooling circuit.

1. Remove a seawater hose from the exchanger. Do not drain the exchanger.
2. Pressurize the closed cooling circuit to 14-20 PSI (97-138 kPa) with a radiator tester.
3. If seawater begins to flow from the nipple there is a leak.

FOR BLOCKAGE:

IMPORTANT: Seawater flows THROUGH the tubes in the exchanger. Closed cooling coolant flows AROUND the tubes.

1. Remove end caps and inspect for any blockage in the seawater circuit (broken impeller blades, weeds, etc.).
2. Remove closed cooling circuit hoses and inspect the tubes just inside the nipples. Because the complete exchanger cannot be inspected, the heat exchanger should be replaced if blockage is suspected.

Testing Pressure Cap

Pressure cap is designed to maintain a pressure of approximately its rated capacity (refer to “Specifications”) in closed cooling section once engine has attained operating temperature. Cap should be cleaned, inspected and pressure-tested at regular tune-up intervals or whenever cap is suspected of maintaining improper pressure as follows:

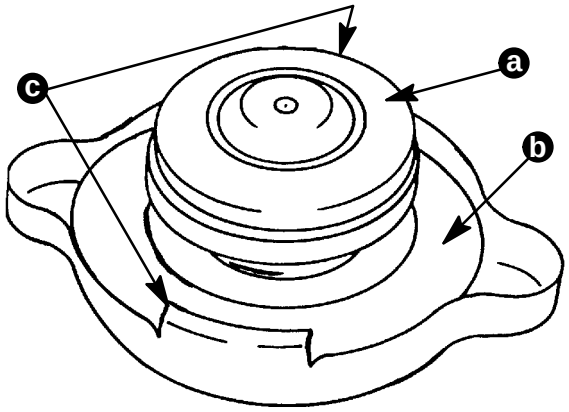
⚠ WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

1. Carefully remove pressure cap from reservoir or heat exchanger.
2. Wash cap with clean water to remove any deposits or debris from sealing surfaces.

Index

3. Inspect gasket (if used) and rubber seal on cap for tears, cuts, cracks or other signs of deterioration. Replace gasket, if damaged, or entire cap if rubber seal is damaged.

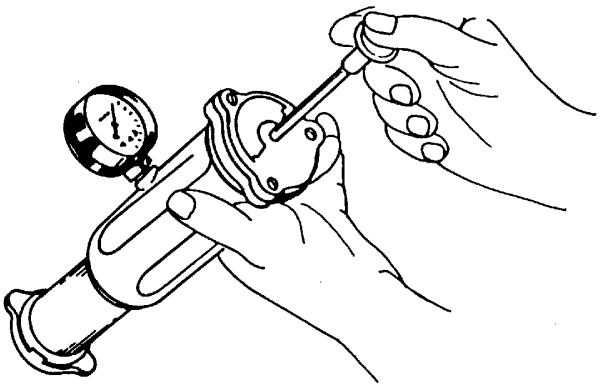


72714

a - Rubber Seal (Cap MUST BE Replaced if Damaged)
b - Gasket (Look for Cracks under Gasket)
c - Locking Tabs (1 Hidden)

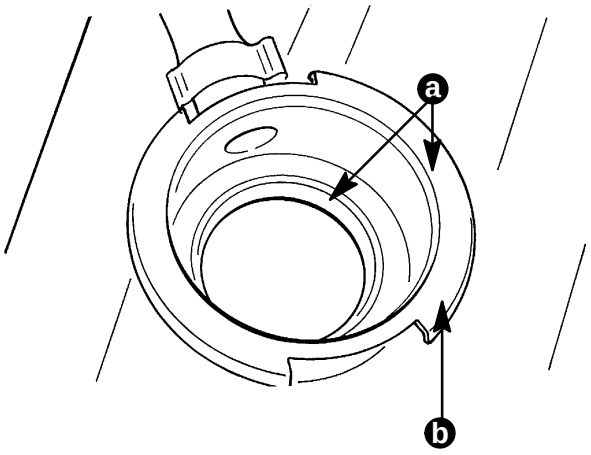
4. Check that locking tabs on cap are not bent or damaged.

5. Using a cooling system pressure tester (similar to one shown), test cap to be sure that it releases at proper pressure and does not leak. (Refer to instructions which accompany tester for correct test procedure.) Cap must relieve pressure at 14 PSI (97 kPa), and must hold rated pressure for 30 seconds without going below 11 PSI. Replace cap if it fails to fall within these limits.



72716

IMPORTANT: Before reinstalling cap in next step, examine lower inside sealing surface in filler neck to ensure that it is perfectly smooth and free of debris. Also, inspect cam lock flanges on sides of filler neck to be sure that they are not bent.



72715

a - Inspect for Damage
b - Cam Lock Flange

6. Reinstall cap on reservoir or heat exchanger.

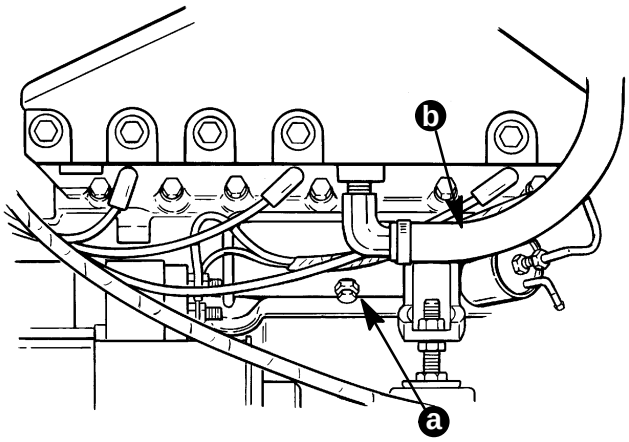
Thermostat

Removal

1. Follow instructions “a” and “b”:
   a. Drain coolant from exhaust manifolds by removing lower hose or drain plugs from each manifold. Be sure to drain both port and starboard sides.

NOTE: *If coolant flow is restricted or fails to occur, a wire should be repeatedly inserted into all drain holes to insure there are no obstructions in passages. Remove petcock, if necessary, to insert wire completely into drain hole.*

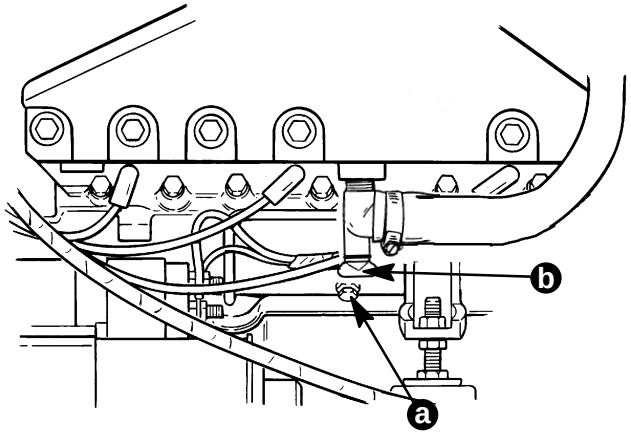
b. Drain engine block by removing plug or opening petcocks. Be sure to drain both port and starboard sides.



72993

Port Side Shown

a - Drain Plug (Cylinder Block)
b - Hose

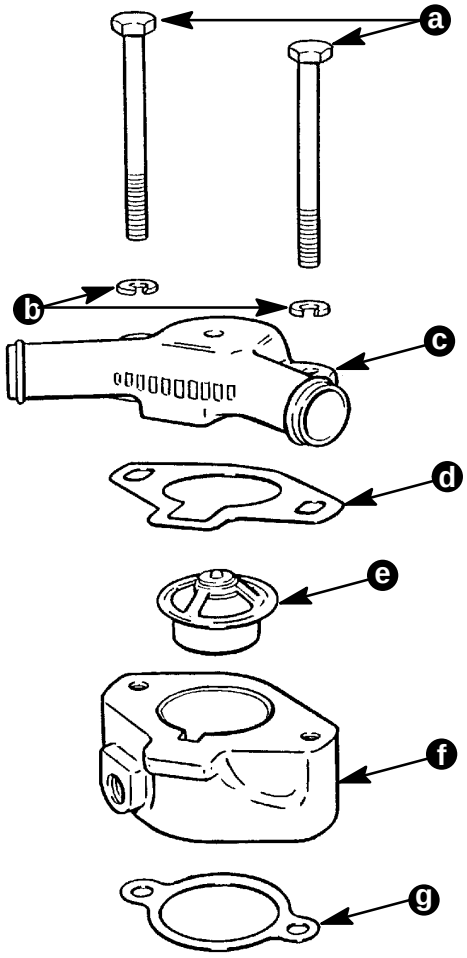


a - Drain Plug (Cylinder Block)
b - Drain Plug (Exhaust Manifold)

2. Disconnect hoses from thermostat cover.
3. Remove thermostat cover attaching bolts and lockwashers, then remove cover and gasket.

NOTE: *Some engines may be equipped with a Lifting Eye bracket (not shown following) under thermostat cover bolts. Observe orientation so that it may be installed during reassembly exactly as before removal.*

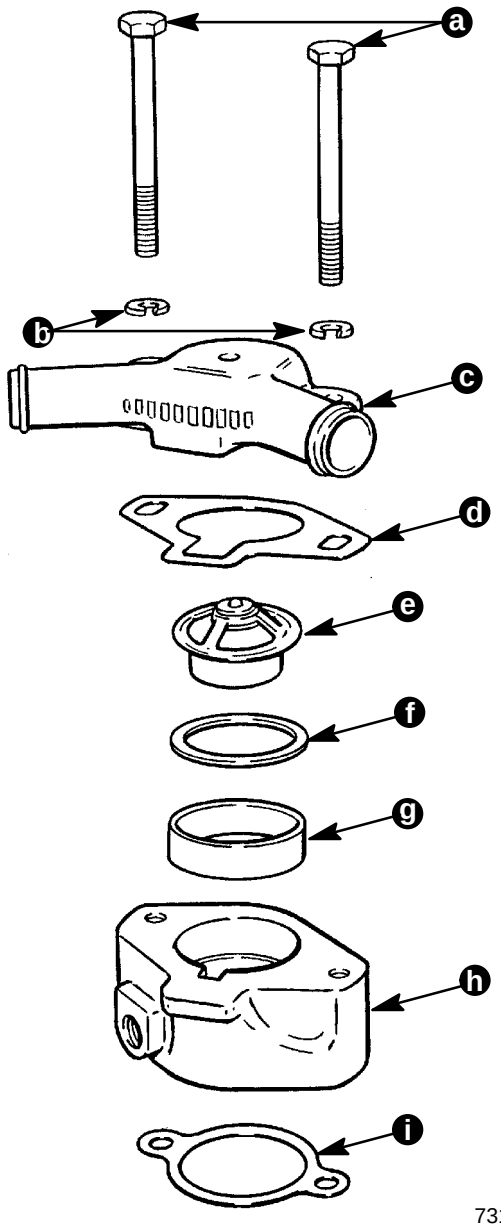
4. Remove thermostat from thermostat housing.



73111

Models Without Sleeve

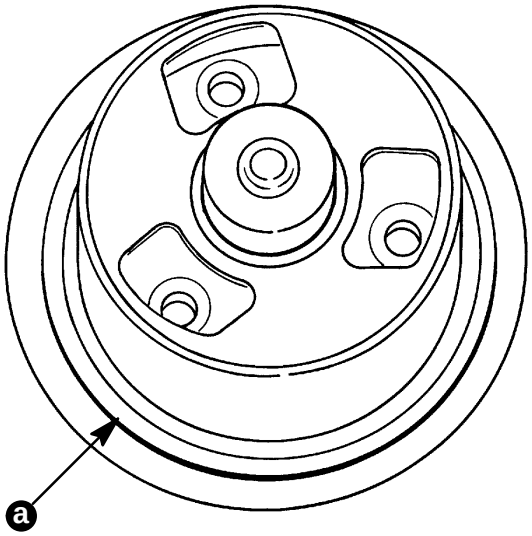
a - Bolts
b - Lockwashers
c - Cover
d - Gasket
e - Thermostat (Typical)
f - Housing
g - Gasket With Continuity Rivets



73110

Testing

1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect thermostat for corrosion or other visible damage.
3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leakage by holding it up to lighted background. Light leakage around the thermostat valve indicates that thermostat is not closing completely and should be replaced. (A small amount of leakage at one or two points around the valve perimeter is acceptable.)



72717

Brass Thermostat (Stainless Steel Similar)

a - Check for Light Leakage Around Perimeter of Valve

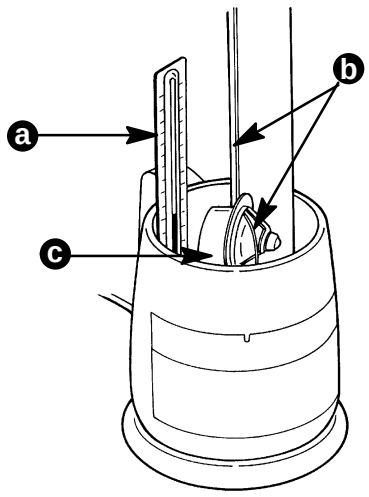
Models With Sleeve

a - Bolts
b - Lockwashers
c - Cover
d - Gasket
e - Thermostat
f - Cork Gasket (DO NOT Use Perfect Seal)
g - Sleeve (Turned in Lip Toward Thermostat)
h - Housing
i - Plugs (2)
j - Gasket With Continuity Rivets

4. Check opening and closing temperature of thermostat (using a tester similar to the one shown), as follows:

   a. Fill tester to within 1 in. (25 mm) of top with tap water. Do not use distilled water.

   b. Open thermostat valve and insert thread. Position thermostat on nylon string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.



72675

a - Thermometer
b - Nylon String
c - Thermostat

   c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. Do not allow thermometer to touch container.

IMPORTANT: When performing instructions "d" and "e," water must be agitated thoroughly to obtain accurate results.

   d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread). Thermostat must open at 138-145°F (59-63°C). Thermostat must be completely open at 170°F (77°C).

   e. Unplug tester and allow water to cool to a temperature 10°F (5°C) below specified temperature on thermostat. Thermostat must be completely closed at this temperature.

   f. Replace a thermostat that fails to meet all of the preceding tests.

Installation

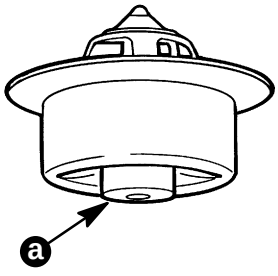
⚠CAUTION

Do not operate engine without cooling water being supplied to the seawater pickup pump, or pump impeller will be damaged.

1. Remove thermostat housing and gaskets. Discard gaskets.
2. Clean gasket surfaces on thermostat cover, thermostat housing and intake manifold.
3. Position lower gasket (with continuity rivets) on intake manifold. Place thermostat housing on gasket.

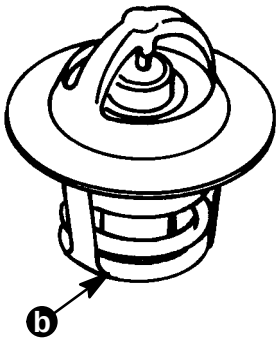
IMPORTANT: If gasket has continuity rivets, do not coat with Quicksilver Perfect Seal, or audio warning temperature switch may not work properly.

4. Install thermostat as shown, into thermostat housing.



Brass Thermostat

72674

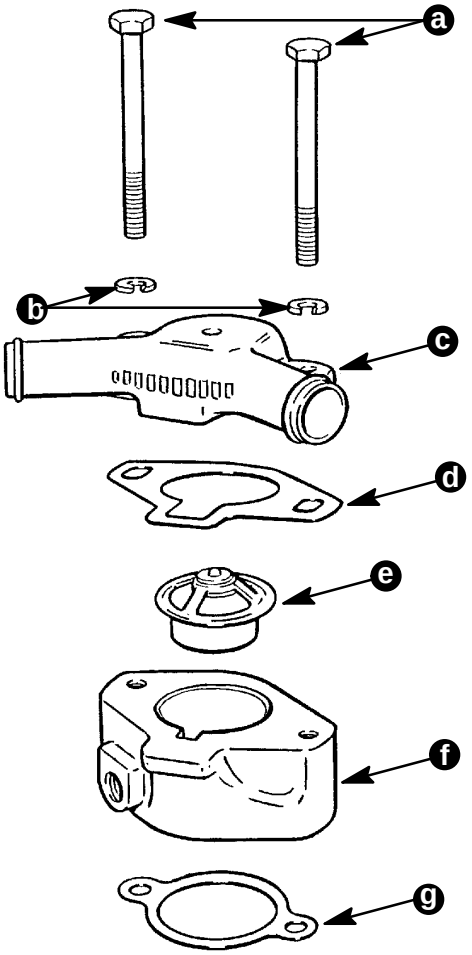


Stainless Steel Thermostat

71801

a - Install Thermostat With This End (Down) Toward Thermostat Housing

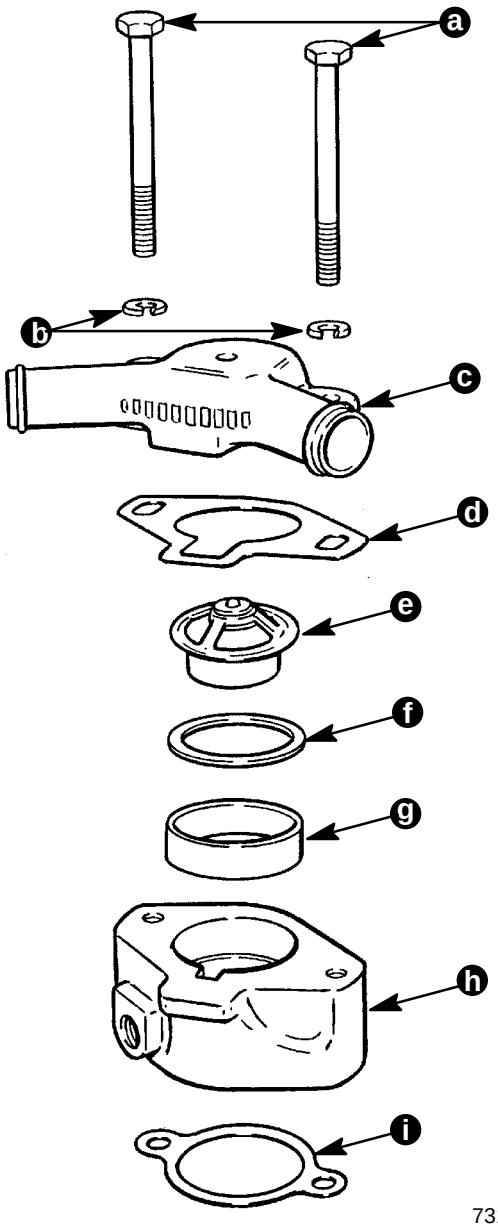
5. Position gasket on thermostat housing and reinstall thermostat cover. Install lifting eye (not shown following) if so equipped. Torque bolts to 30 lb. ft. (41 N·m).



73111

Models Without Sleeve

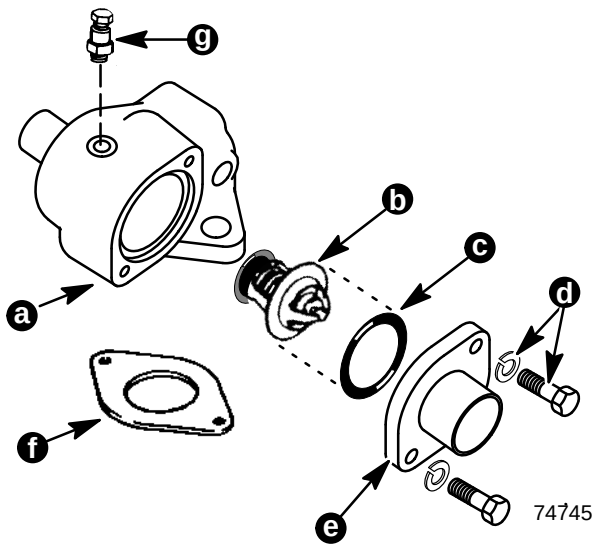
a - Bolts
b - Lockwashers
c - Cover
d - Gasket
e - Thermostat (Typical)
f - Housing
g - Gasket With Continuity Rivets



73110

Models With Sleeve

a - Bolts
b - Lockwashers
c - Cover
d - Gasket
e - Thermostat
f - Cork Gasket (DO NOT Use Perfect Seal)
g - Sleeve (Turned in Lip Toward Thermostat)
h - Housing
i - Gasket With Continuity Rivets



Models With Serpentine Belt

a - Thermostat Housing
b - Thermostat
c - Quad-Ring Seal
d - Screws with Lockwashers
e - Thermostat Cover
f - Gasket
g - Bleeder Valve

6. Connect hoses to thermostat cover. Tighten hose clamps securely.

⚠CAUTION

Avoid seawater pickup pump impeller damage. DO NOT operate engine without cooling water being supplied to seawater pickup pump.

7. With boat in the water and/or cooling water properly supplied to seawater pickup pump, start engine and inspect for leaks.

Changing Coolant

NOTICE

For information and procedures on draining the seawater cooling system, refer to SECTION 6A. For cold weather or extended storage, refer to SECTION 1B.

Closed Cooling Section

Closed cooling section of closed cooling system should be kept filled year-round with recommended coolant solution. Do not drain closed cooling section for storage, as this will promote rusting of internal surfaces. If engine will be exposed to freezing temperatures, make sure that closed cooling section is filled with an ethylene glycol antifreeze and water solution, mixed to manufacturer's recommended proportions, to protect engine to lowest temperature to which it will be exposed. If necessary, change coolant.

Coolant Recommendations

⚠CAUTION

Alcohol or Methanol base antifreeze or plain water are not recommended for use in fresh water section of closed cooling system at any time.

It is recommended that the coolant section of closed cooling system be filled with 50/50 mixture of ethylene glycol antifreeze and water. In areas where the possibility of freezing DOES NOT exist, it is permissible to use solution of rust inhibitor and water (mixed to manufacturer's recommendations).

Change Intervals

Drain and flush coolant from the closed cooling system at least every two years or whenever exhaust gases have entered the system.

Draining Instructions

⚠WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes. On later models with two piece petcock, removal of petcock may be required so that wire can be inserted completely into drain hole.

IMPORTANT: Engine must be as level as possible to ensure complete draining of cooling system.

IMPORTANT: Closed cooling section must be kept filled year round with recommended coolant. If engine will be exposed to freezing temperatures, make sure closed cooling section is filled with an ethylene glycol antifreeze and water solution properly mixed to protect engine to lowest temperature to which it will be exposed.

Index

IMPORTANT: Do not use Propylene Glycol Antifreeze in the closed cooling section of the engine.

The following draining instructions apply to all engines equipped with closed cooling. The location of petcocks that require opening and hoses that require removal are represented on the following pages for the individual engines.

IMPORTANT: Observe precautions previously outlined before proceeding.

1. Remove pressure cap from coolant tank.
2. Drain coolant from locations as shown for your model and engine. (Refer to the appropriate diagram on the following “Draining Diagrams” page.)
3. After coolant has drained completely, coat threads of drain plugs with Quicksilver Perfect Seal and install drain plugs and hoses. Tighten clamps and drain plugs securely.
4. Remove coolant recovery bottle from mounting bracket and pour out coolant.
5. Clean system as outlined in “Cleaning System.”
6. Fill system as outlined in “Filling Closed Cooling Section.”

Cleaning System

Closed Cooling Section

Closed cooling section of the cooling system should be cleaned at least once every two years or whenever decreased cooling efficiency is experienced.

A good grade automotive cooling system cleaning solution may be used to remove rust, scale or other foreign material. Always follow manufacturer’s instructions for the cleaner.

If closed cooling section is extremely dirty, a pressure flushing device may be used to flush out remaining deposits. Flushing should be done in direction opposite normal coolant flow to allow water to get behind deposits and force them out. Refer to instructions which accompany flushing device for proper hookup and flushing procedure.

NOTICE

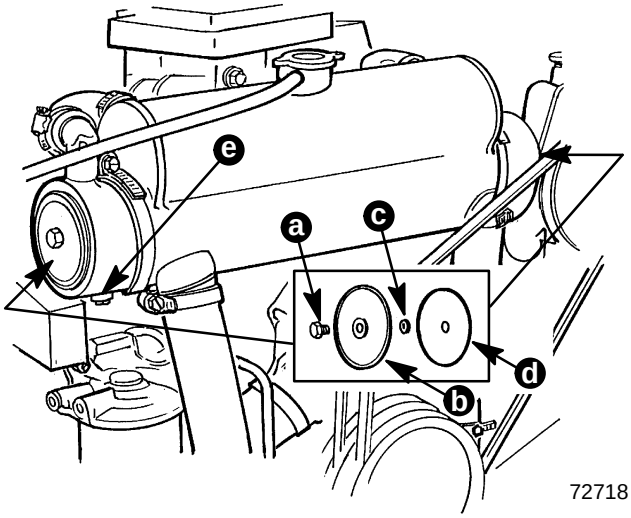
For information and procedures for draining and flushing seawater section of cooling system, refer to SECTION 6A. For cold weather or extended storage, refer to SECTION 1B.

Seawater Section

Cooling efficiency of an engine with closed cooling is greatly dependent upon heat transfer through the tubes within the heat exchanger. During engine operation, contaminants within the seawater (such as salt, silt, lime, etc.) collect on the inside of the tubes, thus reducing heat transfer and greatly decreasing heat exchanger efficiency. It is, therefore, recommended that the seawater section of the heat exchanger be cleaned at least once every two years or whenever decreased cooling efficiency is suspected, as follows:

IMPORTANT: It may be necessary to remove heat exchanger on some models. If heat exchanger is removed, be sure to refill closed cooling section with coolant.

1. Remove seawater drain plug from bottom of heat exchanger and allow water to drain. After water has drained completely, coat threads of drain plug with Quicksilver Perfect Seal and reinstall.



a - Bolt
b - End Cap
c - Sealing Washer
d - Gasket
e - Drain Plug

2. Remove bolts which secure end plates to each end of heat exchanger, then remove end plates, seal washers and gaskets. Discard seal washers and gaskets. Clean gasket material from end plates and heat exchanger.
3. Clean water passages in heat exchanger by inserting a suitable size wire brush into each passage. Use compressed air to blow loose particles out of water passages.
4. Apply Quicksilver Perfect Seal to both sides of new end plate gaskets, then reinstall end plates, using new gaskets and seal washers. (Be sure to install seal washers between end plates and gaskets.) Torque end plate bolts to specifications.

⚠CAUTION

Avoid seawater pickup pump impeller damage. DO NOT operate engine without water being supplied to seawater pickup pump.

5. With boat in the water and/or cooling water properly supplied to seawater pickup pump, start engine and inspect for leaks.

Flushing Seawater Section of Closed Cooling System

If engine is operated in salty, polluted or mineral-laden waters, seawater section of closed cooling system should be flushed periodically (preferably after each use) with fresh water to reduce corrosion and prevent the accumulation of deposits in the system. Seawater section also should be thoroughly flushed prior to storage.

⚠WARNING

When flushing cooling system with boat out of the water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that propeller be removed.

⚠CAUTION

Do not run engine above 1500 RPM when flushing. Suction created by seawater pickup pump may collapse flushing hose, causing engine to overheat.

⚠CAUTION

If cooling system is to be flushed with boat in the water, seacock (if so equipped) must be closed, or water inlet hose must be disconnected and plugged to prevent water from flowing into boat.

⚠CAUTION

To prevent engine or stern drive unit damage DO NOT run engine or drive unit without water being supplied to water intake openings on gear housing.

⚠CAUTION

Watch temperature gauge at dash to ensure the engine does not overheat.

1. Follow instructions appropriate to your model:

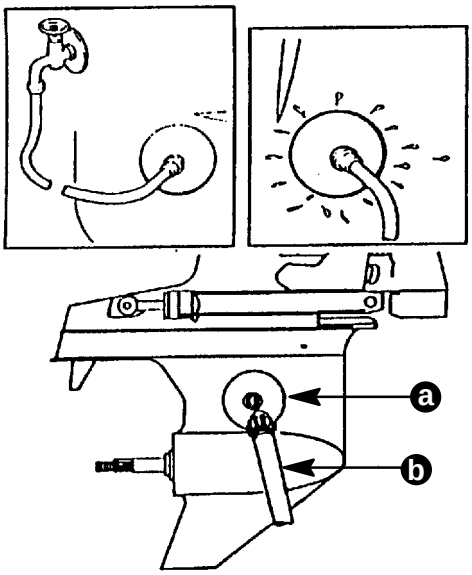
NOTE: *If flushing cooling system with boat in water, raise drive unit to trailer position, install flushing attachment and lower drive unit to full IN/DOWN position.*

Index

a. **All Models:**

(1) Install Quicksilver Flushing Attachment (or equivalent) over water intake openings in gear housing.

(2) Connect hose between flushing attachment and water tap.



a - Quicksilver Flushing Attachment
b - Garden Hose

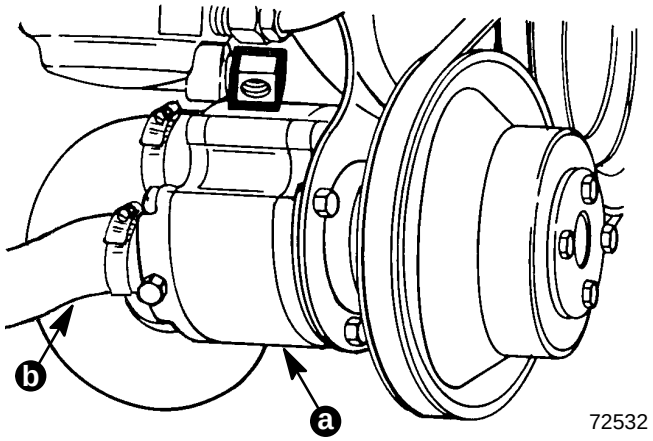
b. **Models Equipped with Belt Driven Seawater Pickup Pump:** In addition to supplying water to the drive (as previously outlined for "**All Models**"), perform the following.

⚠ CAUTION

If cooling system is to be flushed with boat in the water, seacock (if so equipped) must be closed, or water inlet hose must be disconnected and plugged to prevent water from flowing into boat.

(1) Close seacock (if so equipped) or disconnect and plug seawater inlet hose.

(2) Loosen hose clamp and remove seawater inlet hose at location shown. Connect an additional tap water hose to inlet fitting using an appropriate adaptor.



a - Seawater Pickup Pump
b - Seawater Inlet Hose

2. Partially open water tap (approximately 1/2 maximum capacity) and allow drive unit and cooling system to fill completely. Do not use full tap water pressure.

NOTE: *Drive unit is full when water is discharged out of drive unit, and/or seawater section of closed cooled system is full when water is discharged through propeller.*

3. Place remote control lever in NEUTRAL position and start the engine. Operate engine at idle speed in NEUTRAL gear for 10 minutes or until discharge water is clear, then stop engine.

4. Shut off tap water. Remove hose and flushing attachment from drive unit. On belt driven seawater pickup pump models, also remove hose and flushing attachment from pump inlet.

5. Follow instructions "a" or "b."

⚠ CAUTION

If boat is in the water, seacock (if so equipped) must remain closed until engine is to be restarted, to prevent contaminated water from flowing back into cooling system. If boat is not fitted with a seacock, water inlet hose must remain disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engine.

a. **If equipped with seacock:** Observing precaution above, open seacock.

b. **If NOT equipped with seacock:** Observing precaution above, remove plug from seawater inlet hose and reconnect seawater inlet hose. Tighten hose clamps securely.

Draining Seawater Section of Closed Cooling System

NOTICE

For cold weather or extended storage information and procedures, refer to SECTION 1B.

Draining Precautions

⚠CAUTION

If boat is in the water, seacock (water inlet valve), if so equipped, must be left closed until engine is to be restarted to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be left disconnected and plugged to prevent water from flowing back into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel of the boat with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engine.

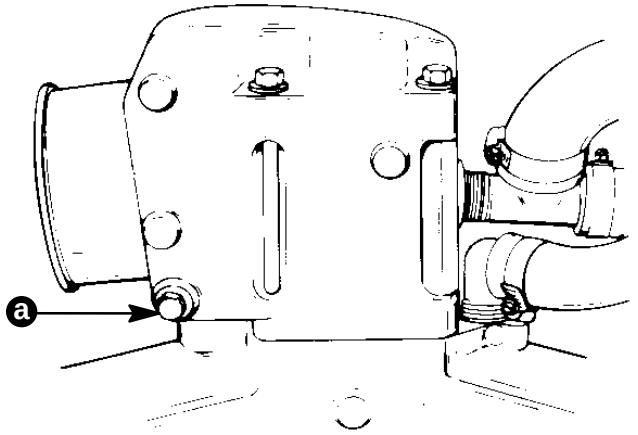
IMPORTANT: Observe the following information to ensure complete draining of cooling system.

- **Engine must be as level as possible.**
- **A wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages.**

IMPORTANT: To prevent threads in manifolds, elbows and cylinder blocks from rusting out during storage, reinstall plugs using Quicksilver Perfect Seal on threads. Never leave drain plugs out during storage.

NOTE: *If possible, place a container under drains and hoses to prevent water from draining into boat.*

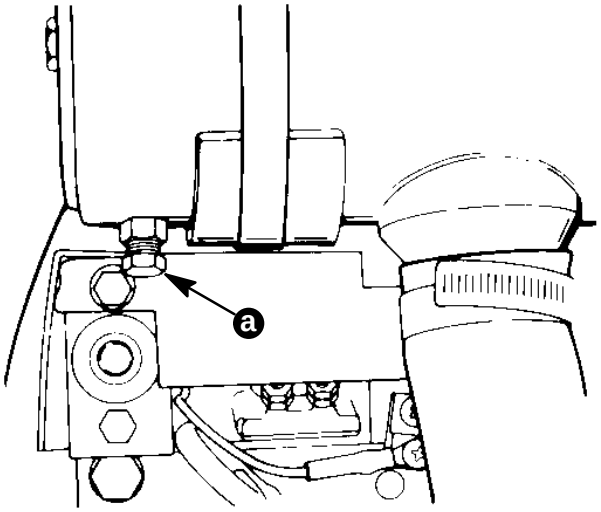
1. Close seacock (if so equipped) or disconnect and plug seawater inlet hose.
2. Check that engine is as level as possible to ensure complete draining of cooling system.
3. Remove drain plugs from port and starboard exhaust elbows (if equipped).



71330

a - Drain Plug (Port and Starboard)

4. Remove drain plug from heat exchanger.

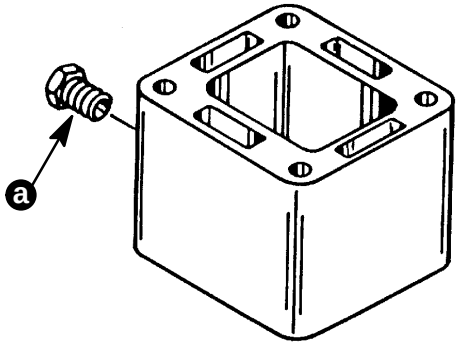


70583

a - Drain Plug

Index

5. If equipped with 3 in. (76 mm) or 6 in. (152 mm) risers, remove drain plug as shown from port and starboard risers (if equipped).



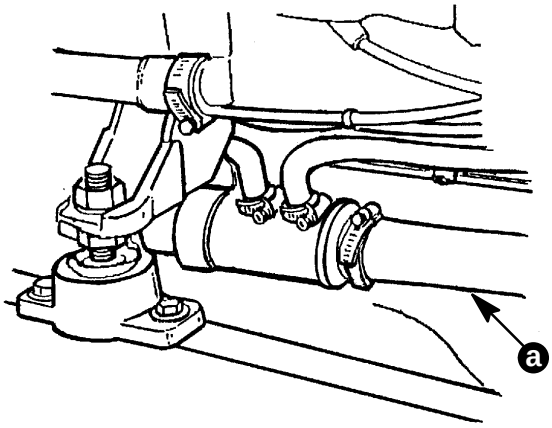
73175

a - Drain Plug (Removed)

6. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses are disconnected.*

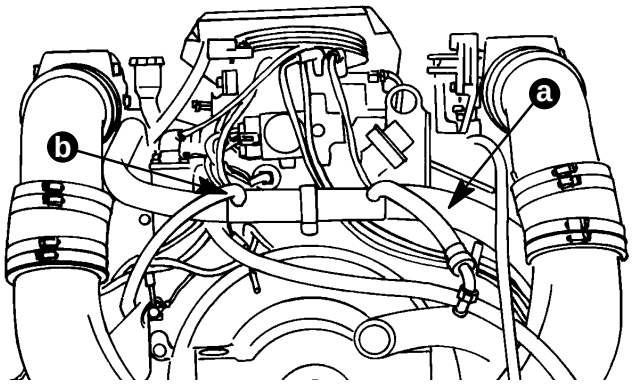
7. Remove the power steering fluid cooler seawater hose, as shown.



72588

Port Side Mounted Fluid Cooler

a - Hose, Seawater Pump to Cover

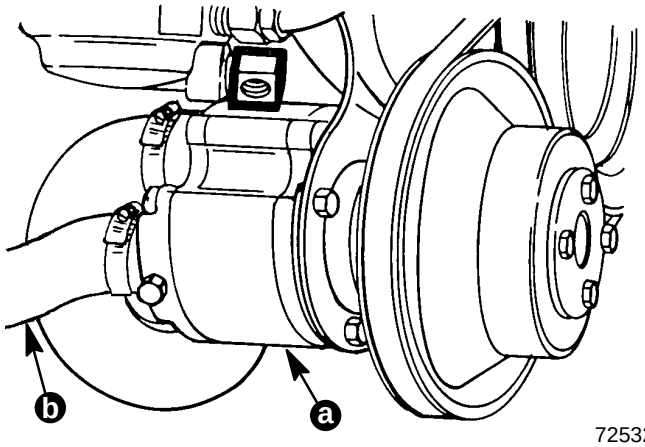


74752

Rear Mounted Fluid Cooler

a - Hose, From Seawater Pump (Bravo) Or From Transom Assembly (Alpha)

8. **On Engines Equipped with a Belt Driven Seawater Pickup Pump**: Remove seawater inlet hose, as shown.



72532

a - Seawater Pickup Pump
b - Seawater Inlet Host

9. Crank engine over SLIGHTLY with starter motor to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.

⚠CAUTION

If boat is in the water or is to remain in the water, seacock (if so equipped) must remain closed until engine is to be restarted, to prevent contaminated water from flowing back into cooling system. If boat is not fitted with a seacock, water inlet hose must be left disconnected and plugged, to prevent contaminated water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engin

10. After seawater section of cooling system has been drained completely, coat threads of drain plugs with Quicksilver Perfect Seal and reinstall. Tighten drain plugs securely. Reconnect hoses and tighten all hose clamps securely. **If NOT equipped with seacock:** seawater inlet hose must remain disconnected and plugged until engine is to be restarted.

Filling Closed Cooling Section

NOTICE

See "Specifications" for approximate closed cooling system capacity and coolant recommendation.

⚠WARNING

Do not remove coolant cap when engine is hot. Coolant may discharge violently.

⚠CAUTION

Alcohol or Methanol based antifreeze or plain water are not recommended for use in fresh water section of cooling system at any time.

⚠CAUTION

Front of engine should be higher than rear to purge trapped air out of the system during initial filling. This will minimize the possibility of air being trapped in the closed cooling section which can cause engine to overheat.

1. Remove coolant cap on heat exchanger.
2. Fill closed cooling system with coolant mixture through heat exchanger fill neck until coolant level is 1 in. (.25 mm) below filler neck.

⚠CAUTION

Avoid seawater pickup pump impeller damage and subsequent overheating damage to stern drive unit. DO NOT operate engine without water being supplied to seawater pickup pump.

⚠CAUTION

Models with belt drive seawater pickup pump must be in the water when running engine because garden hose will not supply enough water to system at higher RPM.

3. With pressure cap off, start engine and run at fast idle (1500-1800 RPM). Add coolant solution to heat exchanger, as required, to maintain coolant level 1 in. (25 mm) below filler neck.
4. After engine has reached normal operating temperature (thermostat is fully open), and coolant level remains constant, fill heat exchanger to bottom of filler neck.
5. Observe engine temperature gauge to make sure that engine operating temperature is normal. If gauge indicates excessive temperature, stop engine immediately and examine for cause.
6. Install pressure cap on heat exchanger.
7. Remove cap from coolant recovery reservoir and fill to FULL mark with coolant solution. Reinstall cap.
8. With engine still running, check hose connection, fittings and gaskets for leaks.

IMPORTANT: Engine overheating is often due to air being trapped in closed cooling section. Purge air by running engine at 2000 RPM for 10 minutes.

⚠WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

9. Recheck coolant level after first open-throttle boat test and add coolant, if necessary.
10. Maintain coolant level in coolant recovery reservoir between ADD and FULL marks with engine at normal operating temperature.

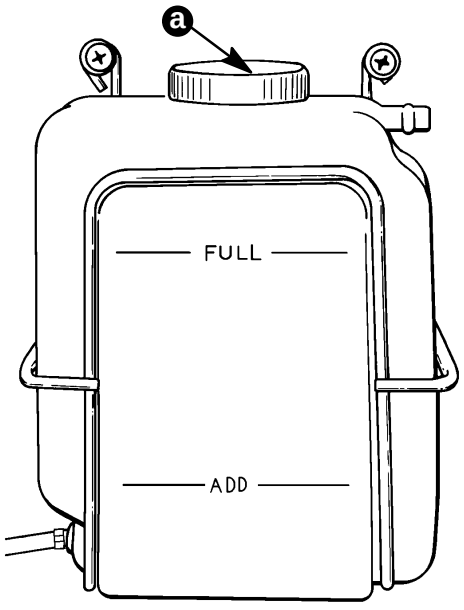
Closed Cooling System With Raw Water Flow Thru Exhaust Manifold (Engines With Serpentine Belt Only)

Maintaining Closed Cooling System Coolant

At least weekly, before starting engine, check to ensure that coolant is visible in coolant recovery bottle.

If coolant is not visible, check coolant section of cooling system (including coolant recovery system) for leaks and repair, as necessary. Refill coolant section with recommended coolant solution, as outlined under “Changing Closed Cooling System Coolant,” following.

If coolant is visible, start engine and run until it reaches normal operating temperature, then recheck coolant level in coolant recovery bottle. Coolant level MUST BE between the “ADD” and “FULL” marks (on front of bottle). If level is low, remove fill cap from coolant recovery bottle and add required amount of coolant solution. Use a 50/50 mixture of ethylene glycol antifreeze and pure, soft water for coolant additions, if frequent additions of coolant are required, check coolant section for leaks.



71712

a - Fill Cap

IMPORTANT: ALCOHOL OR METHANOL BASE ANTIFREEZE OR PLAIN WATER ARE NOT RECOMMENDED FOR USE IN CLOSED COOLING SYSTEM AT ANY TIME. In areas where ethylene glycol is not available, and the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and pure, soft water (mixed to manufacturer’s recommendations).

⚠ WARNING

Coolant section of Closed Cooling System is equipped with a 16 psi (110 kPa) pressure cap (fill cap). Before removing pressure cap, following, first allow engine to cool down, as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn pressure cap 1/4-turn to allow any pressure to escape slowly, then push down and turn cap all-the-way off.

Occasionally, check to ensure that coolant recovery system is functioning properly by removing pressure cap from heat exchanger and checking level. Coolant level should be up to bottom of heat exchanger filler neck. If low, inspect entire coolant section (especially coolant recovery system) for leaks and repair, as necessary.

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until its contact stops on filler neck.

Index

Checking Coolant for Alkalinity

⚠WARNING

Coolant section of Closed Cooling System is equipped with a 16 psi (110 kPa) pressure cap (fill cap). Before removing pressure cap (in next step), first allow engine to cool down, as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn pressure cap 1/4-turn to allow any pressure to escape slowly, then push down and turn cap all-the-way off.

Coolant in closed cooling section of cooling system should be changed every two years and should be checked for alkalinity at least once between change intervals. To check coolant for alkalinity, proceed as follows:

1. Obtain pink litmus paper from a local supplier (drug store, pet shop, etc.).
2. Remove pressure cap from heat exchanger and insert one end of pink litmus paper into coolant.
3. If pink litmus paper turns blue, coolant is alkaline and need not be replaced.
4. If pink litmus paper remains pink, coolant is not alkaline and MUST BE REPLACED, as explained under “Changing Fresh Water Coolant,” following.

Changing Coolant

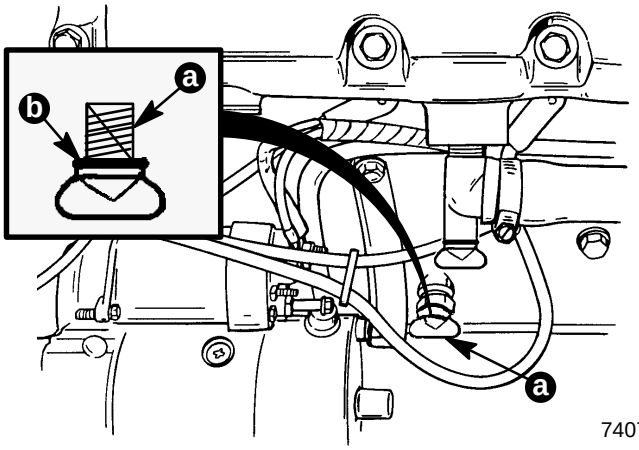
DRAINING INSTRUCTIONS

1. Remove coolant recovery bottle and pour out coolant.

⚠WARNING

Coolant section of Closed Cooling System is equipped with a 16 psi (110 kPa) pressure cap (fill cap). Before removing pressure cap, first allow engine to cool down, as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn pressure cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

2. Remove pressure cap from heat exchanger.
3. Remove drain plugs on each side of cylinder block or fitting, as shown.

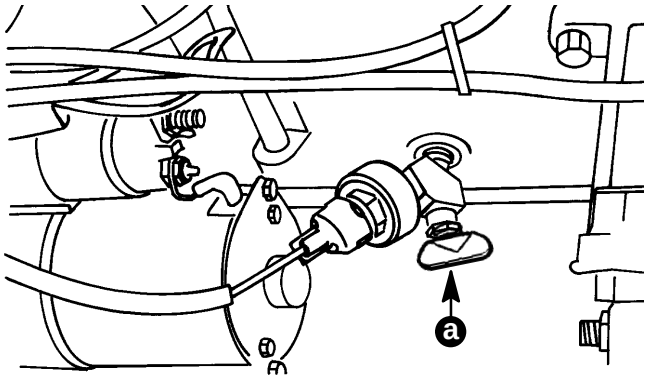


Carbureted Engines, Starboard Side (Port Side Similar)

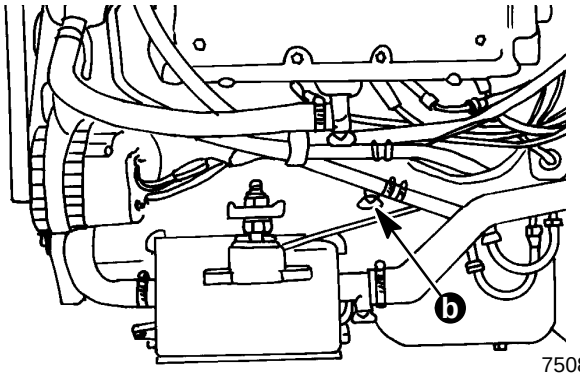
a - Typical Drain Plug
b - Sealing Washer

⚠CAUTION

Avoid product damage. Do not disturb the Y-fitting when removing the drain plug. There is an ignition control “Knock Sensor” in the upper hole of the fitting. This sensor must not be loosened or removed. It is tightened to a critical specification at the factory.



EFI Engines Starboard Side

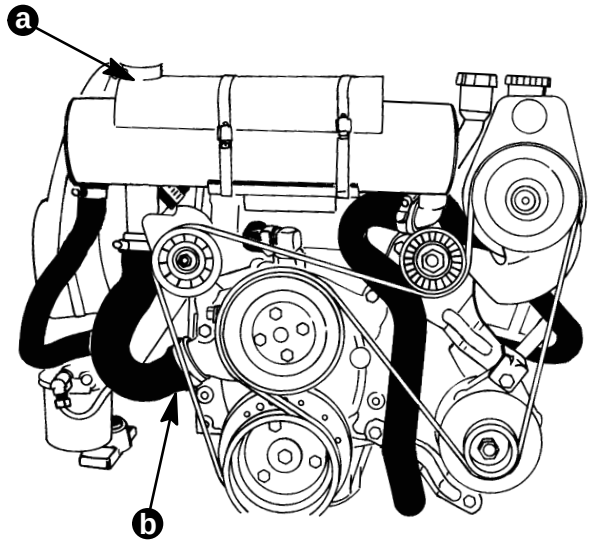


EFI Engines Port Side

a - Drain Plug - from Y-fitting
b - Drain Plug - from Cylinder Block

Index

4. Disconnect heat exchanger-to-circulating pump hose from pump and allow coolant to drain.



Typical Engine Shown

a - Heat Exchanger
b - Heat Exchanger-to-Circulating Pump Hose

5. After coolant has drained completely, reconnect hose, but, do not tighten hose clamps.
6. With drain plugs still removed, flush closed cooling section with plain water until discharge water is clear.
7. Disconnect heat exchanger-to-circulating pump hose once again and drain water.
8. After water has drained completely, apply Perfect Seal to threads of drain plugs and reinstall. Reconnect hose. Be sure to tighten drain plugs and hose clamps securely. Refill section with coolant, as explained following.

FILLING INSTRUCTIONS

⚠CAUTION

Alcohol or Methanol base antifreeze or plain water, are not recommended for use in coolant section of Closed Cooling System at any time.

It is recommended that coolant section of Closed Cooling System be filled with a 50/50 mixture of ethylene glycol antifreeze and pure, soft water. Antifreeze MUST BE used regardless of whether freezing temperatures are or are not expected to provide adequate corrosion protection. In areas where ethylene glycol antifreeze is not available and the possibility of freezing DOES NOT exist, it is permissible to use a solution of rust inhibitor and pure, soft water (mixed to manufacturer's recommendations).

NOTE: *Coolant section capacity is approximately 4 U.S. Gallons (15 L).*

1. Fill coolant section of Closed Cooling System with coolant mixture as follows:
   a. Open bleeder valve on thermostat housing.
   b. Fill with coolant mixture through heat exchanger fill neck until coolant appears at bleeder valve opening.
   c. Close bleeder valve securely.
   d. Continue filling until coolant level is into filler neck and begins to flow into coolant recovery bottle plastic tubing.

⚠CAUTION

DO NOT operate engine without water flowing thru seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or stern drive unit may result.

- **Front of engine should be higher than rear to purge trapped air out of the system during initial filling. This will minimize the possibility of air being trapped in the closed cooling section which can cause engine to overheat.**

IMPORTANT: This closed cooling system flows coolant at a high rate. Higher idle speeds increase dispersion of trapped air into system making it more difficult to purge trapped air. Operate at idle during filling and air purging when specified.

2. Start engine and run AT IDLE. Add coolant solution to heat exchanger, as required, to maintain coolant level at filler neck. After engine has reached normal operating temperature (thermostat is fully open), and coolant level remains constant, fill heat exchanger until coolant level is into filler neck and begins to flow into coolant recovery bottle plastic tubing.
3. Remove cap from coolant recovery reservoir and fill to “Full” mark with coolant solution. Reinstall cap.
4. Lift recovery bottle and plastic tubing *above* heat exchanger filler neck. Allow coolant to flow down through tubing to purge air through filler neck fitting.
5. Install pressure cap on heat exchanger.
6. With engine still running, check hose connections, fittings and gaskets for leaks. Also observe engine temperature gauge to make sure that engine operating temperature is normal. If gauge indicates excessive temperature, stop engine immediately and examine for cause.

⚠WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

7. Recheck coolant level after first open-throttle boat test and add coolant, if necessary.
8. Maintain coolant level in coolant recovery reservoir between “Add” and “Full” marks with engine at normal operating temperature.

Coolant section of Closed Cooling System should be kept filled year around with recommended coolant solution. DO NOT drain coolant, fresh water section, for storage, as this will promote rusting of internal surfaces. If engine will be exposed to freezing temperatures, make sure that coolant section is filled with ethylene glycol antifreeze and water solution, mixed to manufacturer’s recommended proportion, to protect engine to lowest temperature to which it will be exposed.

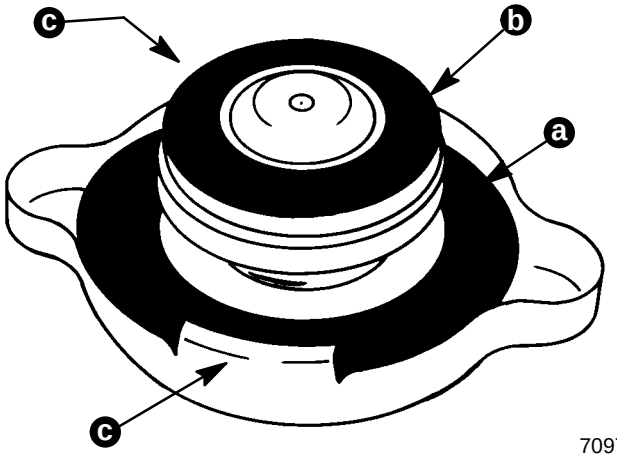
Pressure Cap Maintenance

⚠ WARNING

Allow engine to cool down before removing pressure cap (in next step), as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled down, turn cap 1/4-turn to allow any pressure to escape slowly, then, push down and turn cap all-the-way off.

Pressure cap is designed to maintain a pressure of approximately 16 psi (110 kPa) in coolant section of Closed Cooling System once the engine has attained normal operating temperature. This raises the boiling point of the coolant, thereby increasing the efficiency of the cooling system. To help ensure proper operation, cap should be clean, inspected and pressure tested (at intervals specified in chart), as follows:

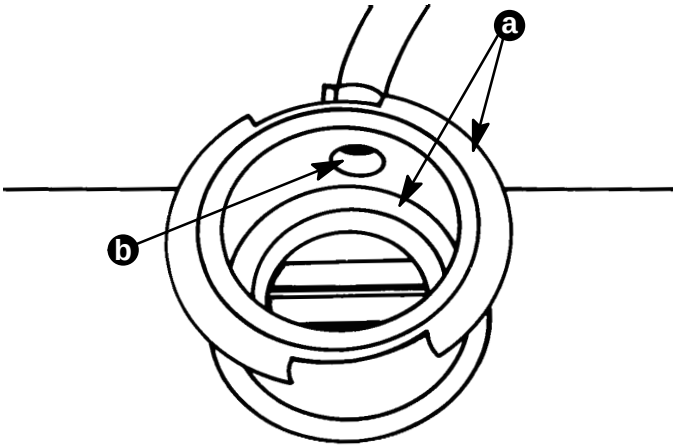
1. Remove pressure cap from heat exchanger.
2. Wash cap with clean water to remove any deposits or debris from sealing surfaces.
3. Inspect rubber seal on cap for cuts, cracks or other signs of deterioration. If seal is damaged, cap MUST BE replaced.



70970

a - Rubber Seal
b - Coolant Recovery Gasket
c - Locking Tabs (1 Hidden)

4. Inspect coolant recovery gasket for deterioration and replace if bad.
5. Check condition of locking tabs on cap. Replace cap, if tabs are bent or cracked.
6. Have pressure cap pressure-tested by your local servicing dealer.
7. Clean sealing surfaces on heat exchanger filler neck with a cloth. Inspect surfaces for any damage or deposits that may prevent cap from sealing properly.
8. Clean coolant recovery passage in heat exchanger filler neck with a wire and blow out with compressed air.
9. Reinstall pressure cap, being sure to tighten until its contacts stops on filler neck.



70260

a - Pressure Cap Sealing Surfaces
b - Coolant Recovery Passage

Flushing Seawater Section

If boat is operated in salty, polluted or mineral-laden waters, seawater section of cooling system should be flushed periodically (preferably after each use) to remove corrosive water and and prevent the accumulation of deposits in the system. Seawater section also should be thoroughly flushed prior to storage. To flush seawater section of cooling system, proceed as follows:

IMPORTANT: If cooling system is to be flushed with boat in the water, water inlet valve (if so equipped) MUST BE closed, or water inlet hose MUST BE disconnected and plugged, to prevent water from flowing into boat and/or cooling system.

IMPORTANT: If a valve is to be installed for the purpose of draining or flushing seawater section, valve MUST have an internal cross-sectional area equal to or greater than water inlet hose to prevent restricting water flow during normal operation. A 1-1/4 in. (32mm) or larger brass ball valve or gate valve is recommended.

1. Disconnect water inlet hose from end of seawater pickup pump.
2. Using appropriate connector, connect city water tap to pump inlet connection and partially open water tap (approximately 1/2 minimum capacity). DO NOT use full city water pressure.

⚠WARNING

When flushing cooling system with boat out of the water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that propeller be removed.

⚠CAUTION

DO NOT run engine above 1500 RPM, as suction created by seawater pickup pump may collapse water supply hole, interrupting water flow and causing engine to overheat.

⚠CAUTION

Watch temperature gauge at dash to ensure that engine does not overheat.

3. Place the remote control lever in neutral position and start engine. Operate engine at idle speed in neutral gear for 10 minutes or until discharge water is clear, then stop engine.
4. Shut off water tap. Remove flushing connector from pump inlet and reconnect water inlet hose. **Be sure to tighten hose clamp securely.**

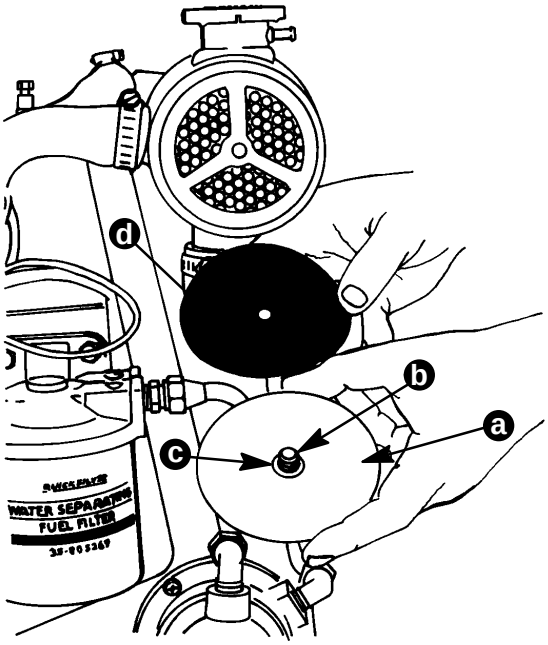
IMPORTANT: If boat is in the water, DO NOT open water inlet valve until engine is to be restarted, to prevent contaminated water from flowing back into engine. If boat is not fitted with a valve, leave water inlet hose disconnected and plugged. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engine.

Cleaning Seawater Section of Heat Exchanger and Fluid Coolers

During operation, contaminants in the seawater may collect on tubes within the heat exchanger and fluid coolers reducing their cooling efficiency. This will cause coolant temperature to gradually rise until an overheating condition exists. To prevent this from happening, the seawater section of heat exchanger, and fluid coolers should be cleaned at least once a year or whenever a gradual rise in temperature is observed on water temperature gauge. Clean seawater section of heat exchanger and coolers.

1. Refer to “Cold Weather or Extended Storage - Seawater Section Draining Instructions” and drain seawater section.

2. Remove end cover, attaching screw, O-ring and rubber gasket, from port and starboard ends of heat exchanger.



71515

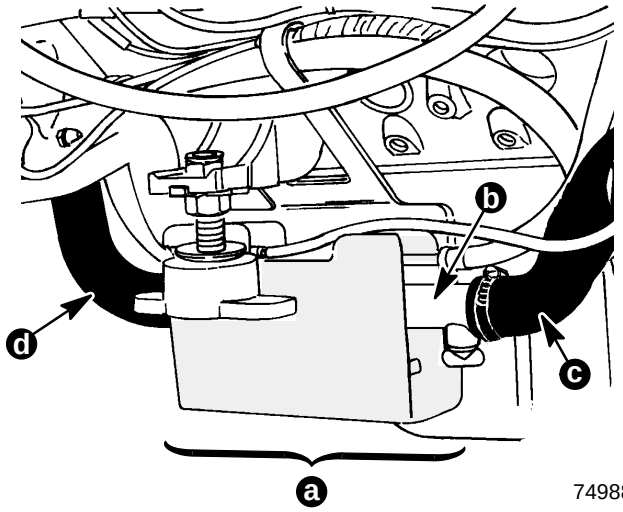
Starboard End Cover Shown (Port Similar)

a - End Cover
b - Screw
c - O-Ring
d - Rubber Gasket

3. Follow appropriate instructions “a” or “b”:

   a. **On Engines Without Cool Fuel System:** Proceed to Step 4.

   b. **On Engines With Cool Fuel System:** Disconnect the fore and aft seawater hoses from Cool Fuel System cooler.

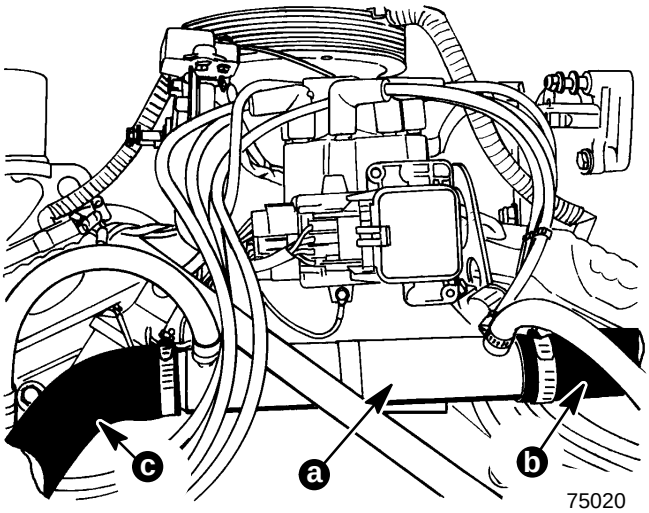


74988

Typical Engine With Cool Fuel System

a - Cool Fuel System
b - Cooler of Cool Fuel System
c - Seawater Hose From Seawater Pump
d - Seawater Hose To Heat Exchanger

4. Disconnect hoses from ends of power steering cooler.



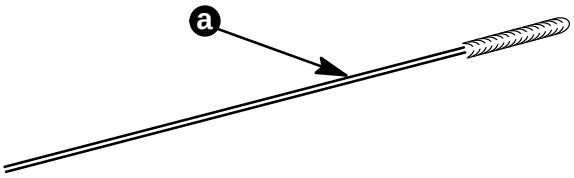
75020

a - Power Steering Fluid Cooler
b - Seawater Hose From Seawater Pump
c - Seawater Hose To Heat Exchanger

5. Remove any debris from cavities on ends of heat exchanger and fluid coolers.

Index

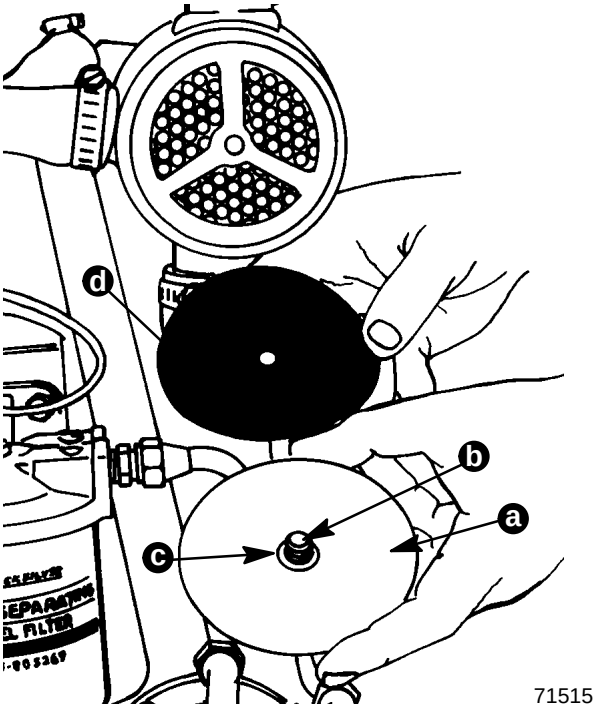
6. Clean tubes (passages) in heat exchanger and coolers by running a suitable wire brush through each tube.



71724

a - Wire Brush, Sized To Fit Passage

7. Rinse out heat exchanger and fluid cooler tubes with tap water from a hose to remove loosened particles.
8. Install end covers on heat exchanger as follows:
   a. Clean gasket mating surfaces on end covers of heat exchanger.
   b. Inspect gaskets and O-rings for damage and replace if necessary.
   c. Reinstall end covers with components shown. Torque end cover screws to 1 to 1-1/2 turns past hand tight.



71515

a - End Cover (Heat Exchanger)
b - Screw
c - O-ring
d - Rubber Gasket

9. Install all hoses previously disconnected . Tighten hose clamps securely.
10. Start engine and check for leaks.

Cleaning Closed Cooling Section

Closed Cooling section of cooling system should be cleaned whenever decreased cooling efficiency (due to internal deposits) is experienced.

A good grade automotive cooling system cleaning solution, that is compatible with copper and cast iron may be used to remove rust, scale or other foreign material. Manufacturer's instructions of particular cleaner being used, should be carefully followed to ensure a safe and effective cleaning operation.

If coolant section is extremely dirty, a pressure flushing device may be used to flush out remaining deposits. Flushing should be done in direction opposite normal coolant flow (with thermostat removed) to allow water to reach behind deposits and force them out (refer to "Cooling System Water Flow Diagram," following). Follow instructions which accompany flushing device for proper hookup and flushing procedure.

Cold Weather or Extended Storage

⚠CAUTION

Seawater section of cooling system MUST BE COMPLETELY drained for winter storage, or immediately after cold weather use, if the possibility of freezing temperatures exist or if the boat is to be stored for an extended period. Failure to comply may result in trapped water causing freeze and/or corrosion damage to engine.

Seawater Section Draining Instructions

IMPORTANT: Observe the following information to ensure complete draining of cooling system.

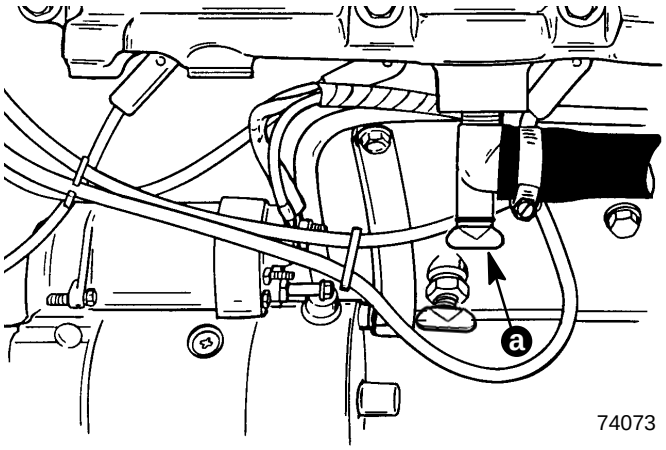
- **Engine must be as level as possible.**
- **A wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages.**
- **It may be necessary to lift, lower or bend disconnected hoses to allow water to drain completely.**

⚠CAUTION

If seawater section of the Closed Cooling System is to be drained with boat in the water, seacock (water inlet valve), if boat is so equipped, must be closed or water inlet hose MUST BE disconnected from seawater pickup pump and plugged, to prevent water from flowing into cooling system and/or boat.

IMPORTANT: If a seacock (water inlet valve) is to be installed for draining purpose, valve used MUST have an internal cross-sectional area equal or greater than water inlet hose to prevent restricting water flow during normal operation. A 1-1/4 in. (32mm) or larger brass ball valve or gate valve is recommended.

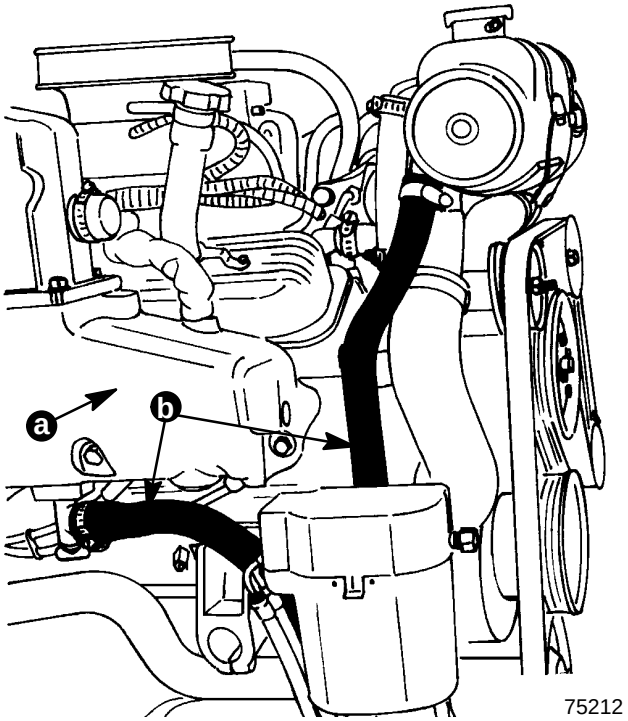
1. Remove drain plug from port and starboard exhaust manifolds.



Starboard Side (Port Side Similar)

a - Drain Plug

2. Disconnect heat exchanger-to-starboard exhaust manifold hose at manifold. Lower hose and allow to drain.



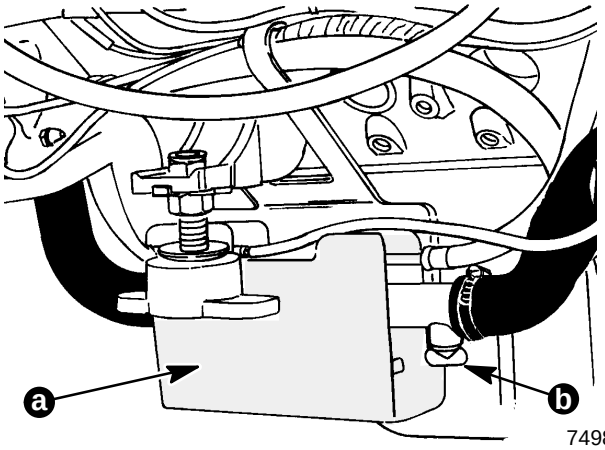
Typical Starboard Hose Shown

a - Starboard Exhaust Manifold

b - Starboard Hose

3. Follow instructions “a” or “b”:

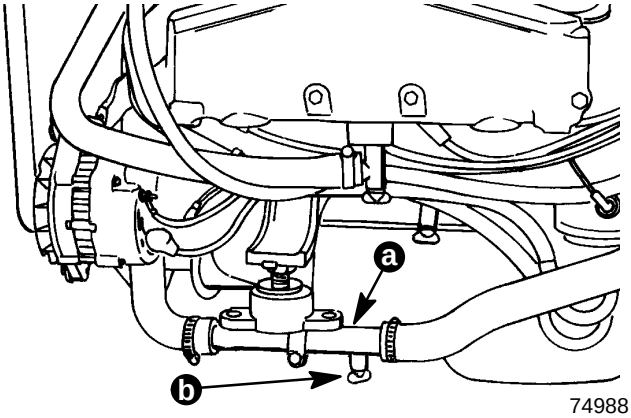
   a. **On Engines <u>With</u> Cool Fuel System:** Remove drain plug from Cool Fuel System seawater pipe.



74988

a - Cool Fuel System Cooler
b - Seawater Pipe Drain Plug

   b. **On Engines <u>Without</u> Cool Fuel System:** Remove drain plug from port side seawater pipe.

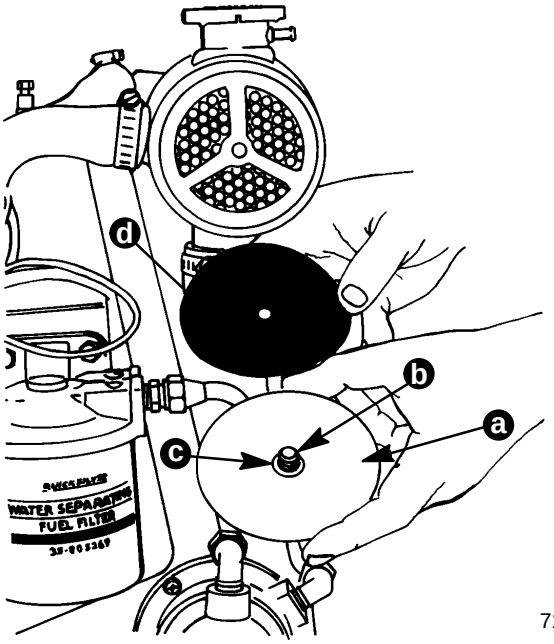


74988

a - Seawater Pipe
b - Seawater Pipe Drain Plug

4. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.
5. Remove end cover, attaching screw, O-ring and rubber gasket, from port and starboard ends of heat exchanger.

IMPORTANT: Use compressed air to blow any remaining water from tubes in the heat exchanger.



71515

Typical Engine and Heat Exchanger Shown

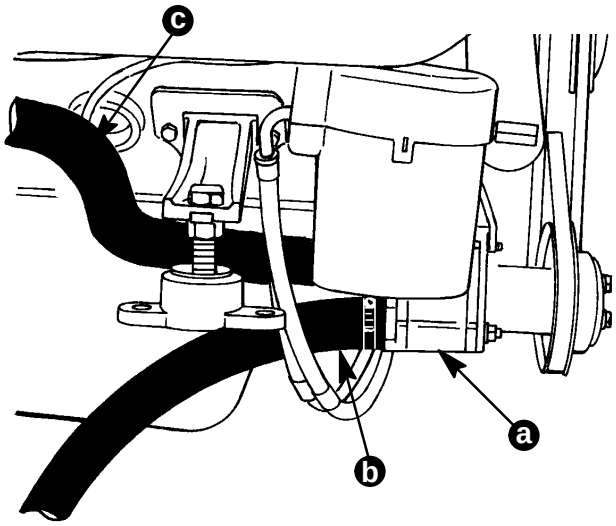
a - End Cover
b - Screw
c - O-ring
d - Rubber Gasket

6. Follow instructions “a” or “b”:

   a. **On Engines WITHOUT Engine Mounted Seawater Pump:** Proceed to Step 7.

   b. **On Engines Equipped WITH Engine Mounted Seawater Pump:**

      (1) Disconnect water inlet and outlet hose from seawater pump. Lower hoses and allow to drain. Reconnect hoses and tighten clamps securely.



74942

a - Seawater Pump
b - Seawater Pump Inlet Hose
c - Seawater Outlet Hose

      (2) Crank engine over slightly, with starter motor, to purge any water trapped in seawater pickup pump. Do not allow engine to start.

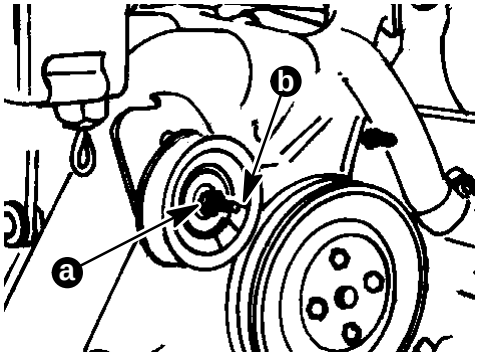
7. After cooling system has drained completely, reinstall drain plugs and connect all seawater hoses. Tighten each securely.

⚠CAUTION

If boat is in the water, water inlet valve (if so equipped) MUST be left closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a valve, water inlet hose MUST BE left disconnected and plugged. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the valve MUST BE opened or the hose reconnected prior to starting the engine.

Serpentine Drive Belt Adjustment

1. Loosen 5/8 in. locking nut on adjustment stud. Leave wrench on adjustment stud.

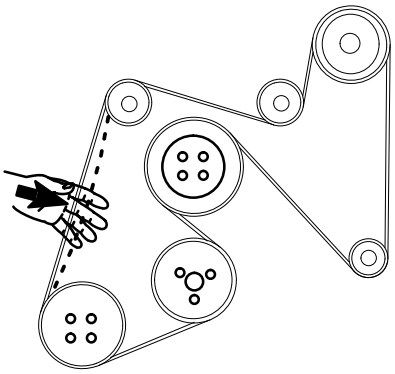


74908

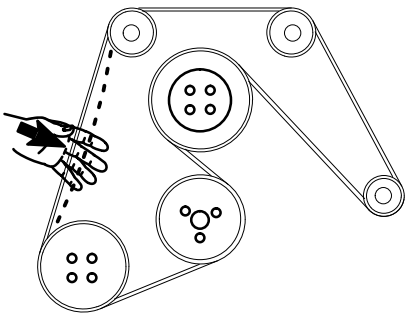
Typical

a - 5/8 In. Locking Nut
b - Adjustment Stud

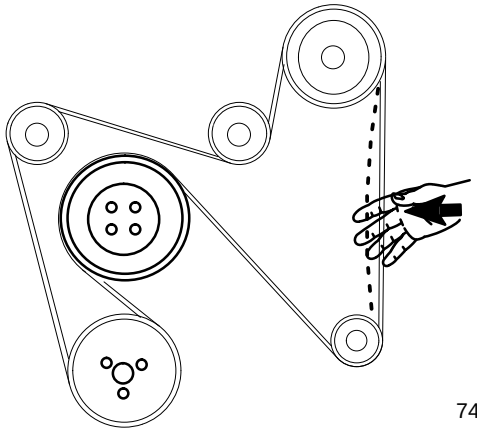
2. Install drive belt on pulleys. Route belt for your type of power package.
3. Belt deflection is to be measured on the belt at the location that has the longest distance between two (2) pulleys.
4. Use 5/16 in. socket and tighten adjusting stud until the correct deflection of 1/4 in. (6 mm) (with moderate thumb pressure, on the belt at location indicated by arrow and dashed lines of the belt) is obtained at location shown.


74933

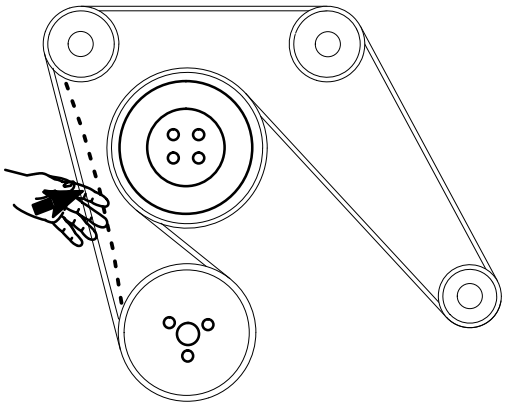
Belt Routing WITH Power Steering and Equipped WITH Engine Mounted Seawater Pump


74932

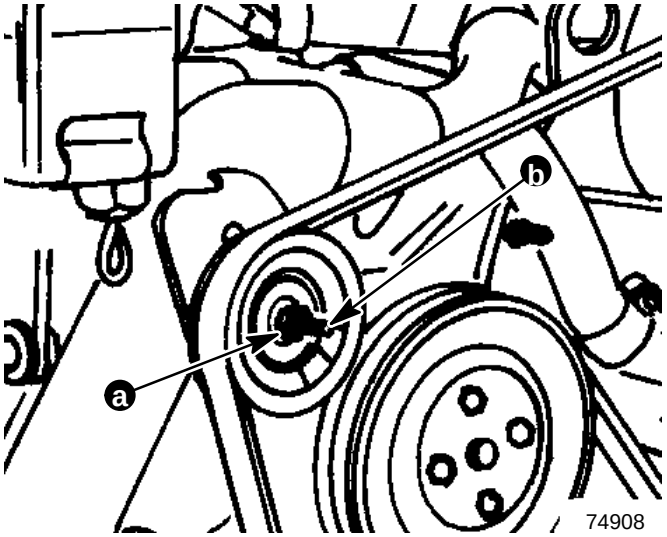
Belt Routing WITHOUT Power Steering and Equipped WITH Engine Mounted Seawater Pump


74931

Belt Routing WITH Power Steering and WITHOUT Engine Mounted Seawater Pump


74930

Belt Routing WITHOUT Power Steering and WITHOUT Engine Mounted Seawater Pump



74908

Typical

a - 5/8 In. Locking Nut
b - Adjustment Stud

5. Operate the engine for a short period of time. Recheck belt adjustment.

Index

Auxiliary Hot Water Heater Installation

IMPORTANT: When connecting a cabin heater or hot water heater, certain requirements must be met.

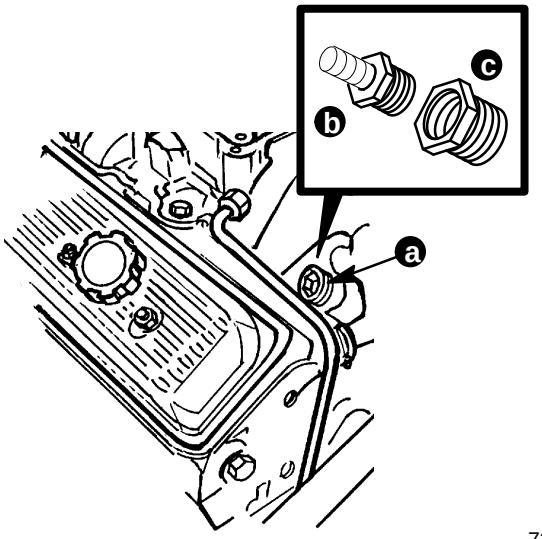
- **Supply hose (from engine to heater) and return hose (from heater to engine) MUST NOT EXCEED 5/8 in. (15.8 mm) I.D. (inside diameter).**
- **Engine with a Closed Cooling System: Heater MUST BE LOWER than fill cap on the heat exchanger. If the heater is higher than the fill cap on the heat exchanger and some coolant is lost in the system, an air pocket may form in the closed cooling system. This, in turn, can cause the engine to overheat.**
- **Make heater connections ONLY at locations described in the following instructions.**
- **Check complete system for leaks after heater is connected into cooling system.**
- **Check for overheating condition (of engine) after heater is connected.**

1. Refer to “Changing Coolant - Draining Instructions”; drain closed cooling system.
2. Inspect for appropriate location of supply hose at following:

NOTE: *Hot water heater supply hose can be connected at several different locations. On some models, there may be other accessories and options that are utilizing these hot water supply locations. One of the following should be available for use when installing a hot water heater system.*

IMPORTANT: Do not reposition engine temperature switch; it must remain where installed by factory.

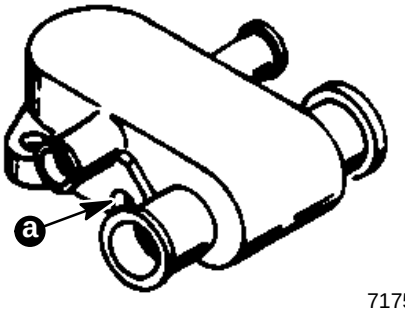
SUPPLY HOSE CONNECTION - ENGINES WITH RAW WATER OR CLOSED COOLING SYSTEM



72708

Primary Location

a - Plug
b - Reducer Bushing
c - Hose Connector

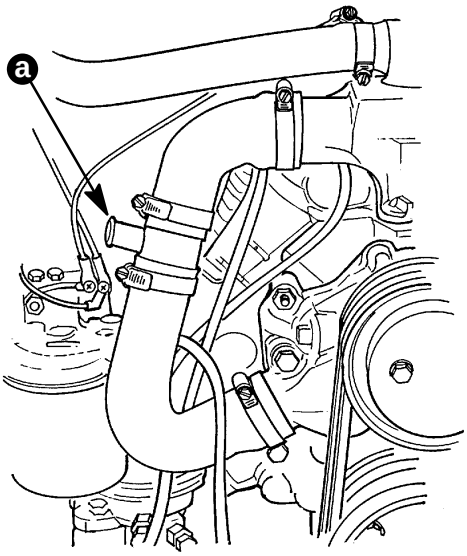


71758

Raw Water Cooling Models - Alternate Location

a - Location for Hot Water Supply (Install Bayonet Fitting Here)

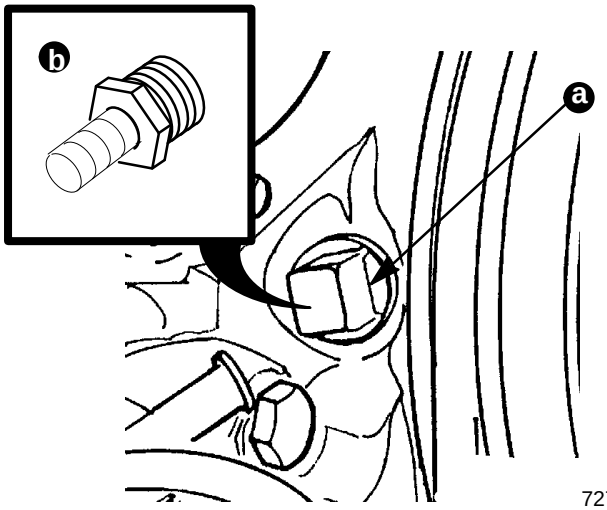
RETURN HOSE CONNECTION - ENGINES WITH RAW WATER OR CLOSED COOLING SYSTEM



72705

Earlier Style Quicksilver Kit Location

a - T-Fitting



72702

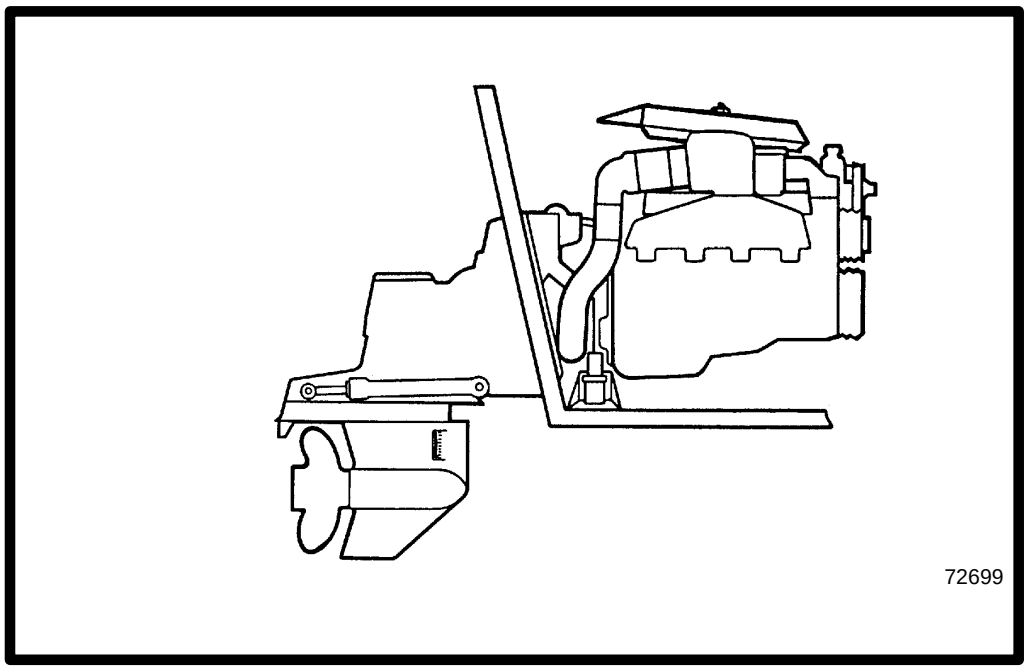
Later Style Quicksilver Kit Location

a - Pipe Plug
b - Hose Connector
c - T-Fitting
d - Hose Clamps

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

EXHAUST SYSTEM



7

A

GENERAL

Index

Table of Contents

	Page
Exhaust System Requirements	7A-1
All Engines	7A-1
Engines With Thru Transom Exhaust	7A-1

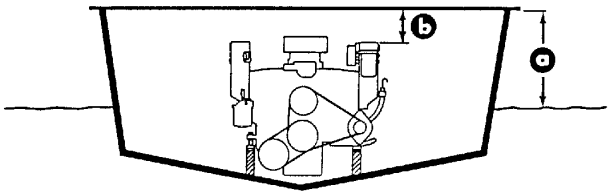
Index

Exhaust System Requirements

All Engines

IMPORTANT: It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install the exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers and severely damage the engine. Damage caused by water in the engine will not be covered by MerCruiser Limited Warranty, unless this damage is the result of defective part(s).

Determine if exhaust elbow risers are required by taking measurements (a) and (b), with boat at rest in the water and maximum load aboard. Subtract (b) from (a). If (a) minus (b) is less than specified in chart, select appropriate size exhaust elbow riser kit and exhaust extension kit that will correctly position exhaust elbow.



72700

Exhaust Elbow Measurement

a - From Waterline to Reference Point (Top of Transom)
b - From Highest Point on Exhaust Elbow to Same Reference Point (Top of Transom)

Model	(a) Minus (b) Must Be at Least
All	13 In. (330 mm)

IMPORTANT: Exhaust hoses must not restrict discharge water flow at exhaust elbow when installed.

Engines With Thru Transom Exhaust

When designing and installing exhaust system, it is very important that the following points be taken into consideration:

1. System layout and construction must prevent cooling system discharge water from flowing back into engine and also must prevent seawater from entering engine via exhaust at any point.
2. The exhaust hoses and pipes must not be higher than exhaust elbows at any point.
3. The exhaust outlet (for routing exhaust to outside of boat) must be located so that a minimum of 1/2 in. (13 mm) per foot (305 mm) downward pitch (drop) exists in the exhaust hose or pipe from the engine exhaust elbow to the outlet, with a minimum drop of 4 in. (100 mm) overall. (This is an American Boat & Yacht Council recommendation.) The drop must be constant so that a low spot does not exist at any point in the exhaust hose or pipe.
4. Exhaust outlet must be slightly above the waterline with boat at rest in the water and full load aboard. Exhaust outlet should be equipped with an internal shutter to prevent seawater from running back into exhaust system. The use of an exhaust flapper on each outlet also is recommended.
5. System must not cause excessive back pressure. Back pressure MUST NOT exceed 4 in. (100 mm) of mercury when measured with a mercury manometer at exhaust elbow outlets. Minimum exhaust hose sizes are given in chart.

Minimum Hose Size		
Model	**Single**	**Dual**
All	4 In. (102 mm)	3 In. (76 mm)

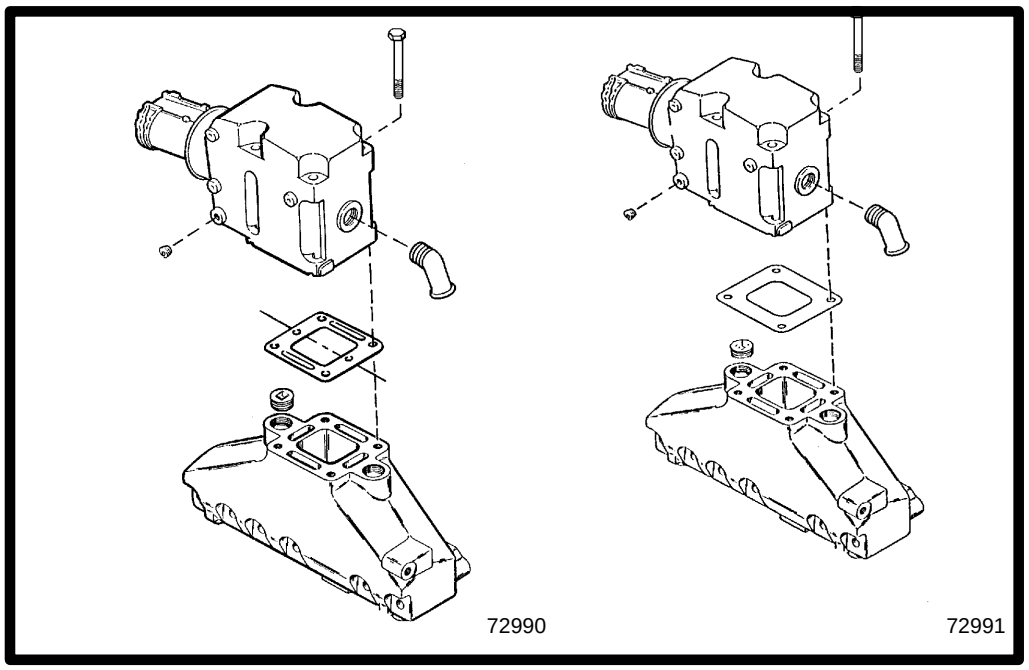
6. Exhaust hoses must be connected to exhaust elbows so that they do not restrict the flow of discharge water from the elbow. If hoses are connected incorrectly, a hot spot in the hose can occur, and can eventually burn through.

There are no kits to convert these engines from thru drive to thru transom exhaust. By using block off plates, inboard exhaust elbows, exhaust hoses and transom outlet fittings, some engines have been converted to thru transom exhaust. In addition to the preceding information, the following should be adhered to:

- **“Exhaust Elbow Measurement” (as previously outlined) must be checked.**
- **Block-off plates (for thru drive exhaust system) must be able to prevent water from entering boat (Quicksilver Block-Off Plate Part Number 97350T). Refer to appropriate Stern Drive Manual.**
- **Exhaust bellows (between gimbal housing and bell housing) should be removed to allow propeller to draw air. Refer to appropriate Stern Drive Manual.**

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

EXHAUST SYSTEM



7

B

MANIFOLD AND ELBOWS

Index

Table of Contents

	Page
Torque Specifications	7B-1
Sealants	7B-1
Removal	7B-1
Cleaning and Inspection	7B-2
Installation	7B-2

Torque Specifications

Fastener Location	Lb. Ft.	N•m
Hose Clamps	Securely	
Exhaust Elbow	25	34
Exhaust Manifold		

Sealants

Description	Part Number
Quicksilver Perfect Seal	92-34227-1

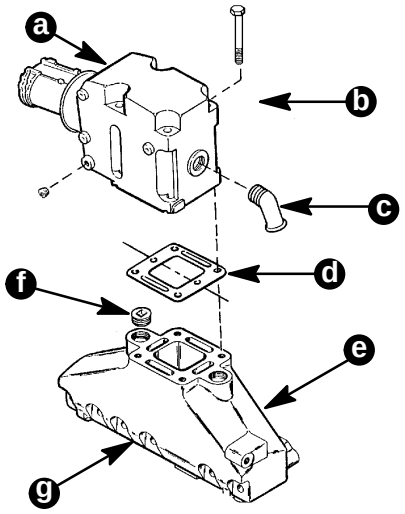
Removal

1. Disconnect battery cables from battery.

⚠CAUTION

Before proceeding, drain water and/or coolant from exhaust elbows and manifolds. Water or coolant MUST BE DRAINED from exhaust elbows and manifolds or some will run into engine combustion chambers when exhaust elbows are removed.

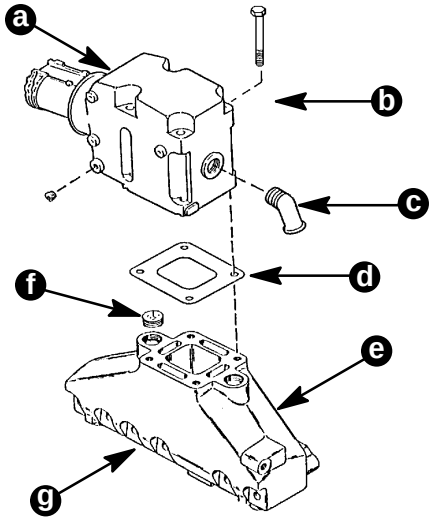
2. Drain water from manifold and exhaust elbow. (Refer to cooling system Section 6A or 6B, depending on model.)
3. Disconnect exhaust bellows and cooling hoses.
4. **Starboard Manifold:**
   a. Disconnect both shift cables. Retain hardware.
   b. Disconnect wires for shift cut-out switch.
   c. Remove shift plate assembly from exhaust elbow.
5. Remove exhaust elbow and risers, if so equipped.
6. Remove exhaust manifold fasteners; remove manifold assembly and discard gaskets.



72991

Cast Iron Elbow With Restrictor Gasket

a - Exhaust Elbow Assembly - Starboard Side Shown
b - Bolts (4)
c - Fitting (45°) or Fitting (Straight)
d - Gasket - Seawater Cooled (Align as Shown)
e - Exhaust Manifold Assembly
f - Plug
g - Bolts (6)

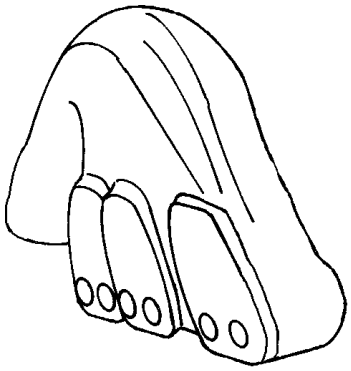


72990

Cast Iron Elbow With Separator Gasket

a - Exhaust Elbow Assembly - Starboard Side Shown
b - Bolts (4)
c - Fitting (45°) or Fitting (Straight)
d - Manifold Separator Gasket
e - Exhaust Manifold Assembly
f - Plug
g - Bolts (6)

MCM 4.3LX / 4.3LXH / 262 MAGNUM SEAWATER COOLED WITH ONE PIECE CAST IRON MANIFOLD



74908

Cleaning and Inspection

1. Clean gasket material from all surfaces and wash parts in solvent.
2. Inspect all parts carefully. Machined surfaces must be clean and free of all marks and deep scratches, or water and exhaust leaks may result.
3. Check water passages for foreign material. Passages must be clean for efficient cooling.
4. If more thorough inspection is desired, pipe plugs may be removed from exhaust manifold and exhaust elbow.

IMPORTANT: If plugs are removed, coat threads with Quicksilver Perfect Seal before reinstalling.

5. Check for cracks.
6. To test manifold body for leaks, block-off plates, plugs, or short hoses with plugged ends must be used. One block-off plate must have a threaded hole for attaching compressed air hose. Use new gaskets when installing block-off plate(s). Apply 40 PSI (276 kPa) of air pressure and submerge manifold in water. Air bubbles will indicate a leak.

Installation

1. Using new gasket, install exhaust manifold to cylinder head. Torque fasteners to 25 lb. ft. (34 N·m).

IMPORTANT: See Section 7C for additional information if exhaust risers are used.

2. Using new gaskets, install exhaust elbows (and risers, if so equipped), to exhaust manifold. Torque fasteners to 25 lb. ft. (34 N·m).
3. Coat threads of drain plugs with Quicksilver Perfect Seal and install. Tighten securely.

STARBOARD MANIFOLD:

   a. Install shift plate assembly on exhaust elbow using hardware retained.
   b. Connect wires for cut-out switch.
   c. Refer to appropriate Stern Drive Service Manual and properly install and adjust both remote control shift cables, using hardware retained.

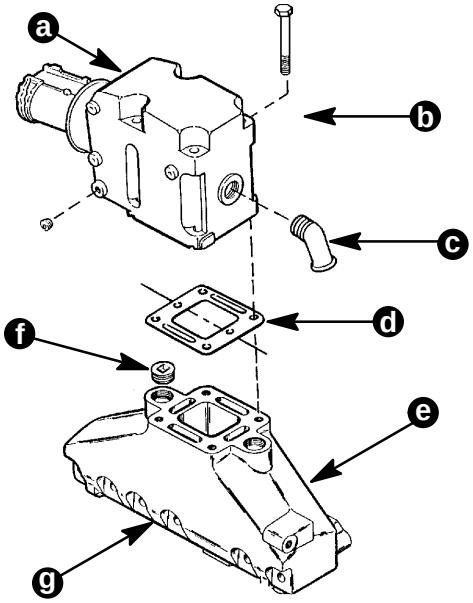
4. Install cooling hoses. Tighten hose clamps securely.
5. Refer to SECTION 6B - “Closed Cooled Models” and refill closed cooling system, if so equipped.
6. Reconnect battery cables to battery. Tighten securely.

⚠CAUTION

Do not operate engine without cooling water being supplied to the seawater pickup pump, or pump impeller will be damaged.

7. Place boat in water and/or properly supply cooling water to seawater pickup pump.

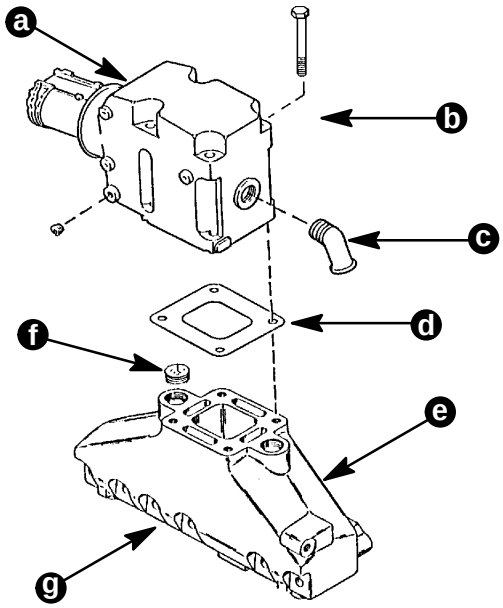
8. Start engine and check for fuel, exhaust and water leaks.



72991

Cast Iron Elbow With Restrictor Gasket

a - Exhaust Elbow Assembly - Starboard Side Shown
b - Bolts (4)
c - Fitting (45°) or Fitting (Straight)
d - Gasket - Seawater Cooled (Align as Shown)
e - Exhaust Manifold Assembly
f - Plug
g - Bolts (6)



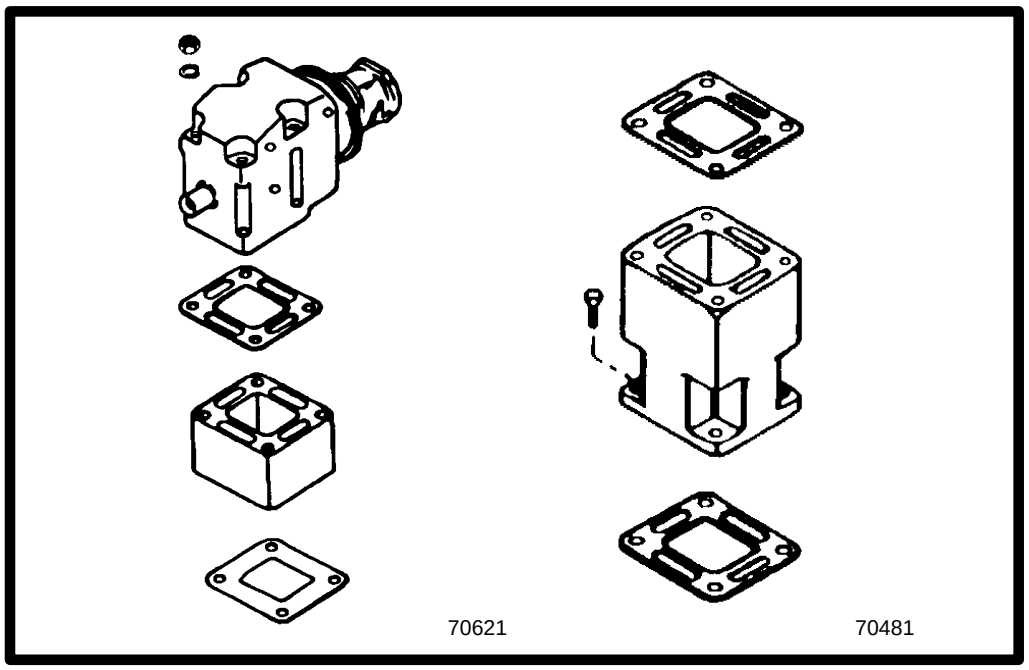
72990

Cast Iron Elbow With Separator Gasket

a - Exhaust Elbow Assembly - Starboard Side Shown
b - Bolts (4)
c - Fitting (45°) or Fitting (Straight)
d - Manifold Separator Gasket
e - Exhaust Manifold Assembly
f - Plug
g - Bolts (6)

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

EXHAUST SYSTEM



7
C

RISERS

Index

Table of Contents

	Page
Exhaust Riser (Kit) Identification	7C-1
Additional Kit	7C-1
Torque Specifications	7C-1
Sealants	7C-1
Replacement Information	7C-1
Engine Preparation and Parts Removal	7C-1
Riser Installation	7C-1
Installation Diagrams	7C-3
3 Inch (76mm) Exhaust Riser Kit 93320A6 Models With Cast Iron Elbows	7C-3
6 Inch (152 mm) Exhaust Riser Kit 93322A4 With Cast Iron Elbows	7C-4

Index

Exhaust Riser (Kit) Identification

3 inch (76 mm) Riser - Kit Part Number	6 Inch (152 mm) Riser - Kit Part Number
93320 A6	93322 A4

IMPORTANT: All listed MCM Models can be adapted to 9 inch (228 mm) exhaust risers by stacking 3 inch (76 mm) riser kit (93320A6) and 6 inch (152 mm) riser kit (93322A4).

Additional Kit

The following additional kit may be installed or needed when risers are installed:

MCM (Stern Drive)	
Item Required	**Kit Part Number**
Exhaust Extension	14865A1

Torque Specifications

Fastener Location	Lb. Ft.	N•m
Exhaust Elbow	25	34
Exhaust Riser		

Sealants

Description	Part Number
Quicksilver Perfect Seal	92- 34227 -1

Replacement Information

Engine Preparation and Parts Removal

⚠CAUTION

If engine has been in service, exhaust elbows and manifolds must be drained to prevent water from entering combustion chambers.

1. Drain exhaust elbows and exhaust manifolds.
2. Remove any items attached to the elbows on the engine and carefully lay them aside. Remember their positioning for reassembly later.
3. Remove fasteners retaining exhaust elbows and risers to manifolds and retain. Remove exhaust elbows.
4. Remove and discard old gaskets. Clean gasket mating surfaces on elbows, manifolds and risers.

Riser Installation

Follow instructions appropriate to your model and riser kit:

1. Refer to “Installation Diagrams” following and assemble riser and components following instructions.

IMPORTANT: Restrictor gaskets or manifold separator gaskets must be installed in order shown.

a. Assemble studs to exhaust manifold and position all gaskets as shown between risers. Install elbow on riser(s) and studs. Attach using nuts and washers.

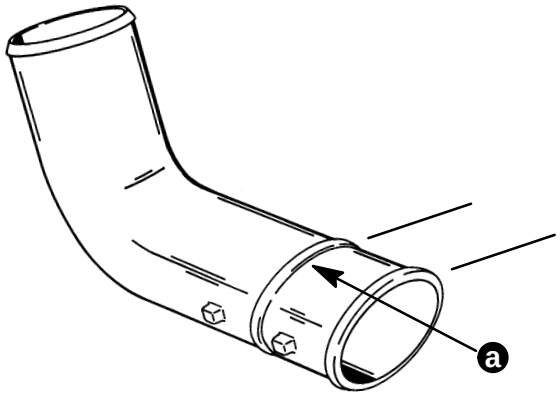
b. After positioning all gaskets as shown, assemble exhaust elbow to riser using studs or screws. Attach hex head screws through riser and into manifold.

NOTE: *Drain plugs in risers must be positioned facing flywheel end of engine, unless otherwise noted.*

2. Torque all fasteners, in a diagonal pattern, to 25 lb.ft. (34 N·m).
3. Place spacers between riser plate, if so equipped, and fasten with existing nuts. Tighten securely.
4. Reattach and tighten securely all parts previously removed from elbow to appropriate position on riser bracket, if so equipped.

IMPORTANT: On starboard elbows with shift plate, install shift plate. Tighten fasteners securely, then adjust shift cables as outlined in appropriate Stern Drive Service Manual.

5. Install appropriate exhaust extension (see "Additional Kits") for MCM Models. Tighten hose clamps securely.



50930

Typical Exhaust Extension (See "Additional Kit" at Front of Section for Kit Part Number.)

a - Cut Along Bottom Edge of Welt for Use with 3 Inch (76mm) Riser

6. Refill closed cooling system, if so equipped. (Refer to Section 6B - "Closed Cooled Models.")

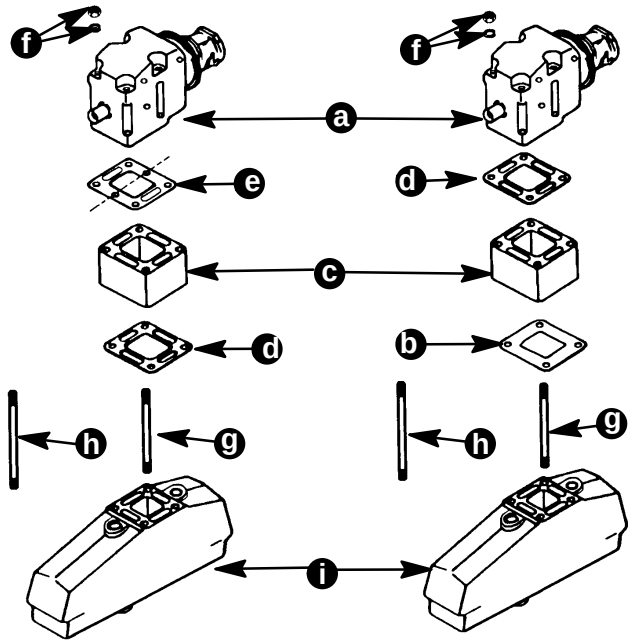
⚠CAUTION

Do not operate engine without cooling water being supplied to the seawater pickup pump, or pump impeller will be damaged.

7. Place boat in water and/or properly supply cooling water to seawater pickup pump.
8. Upon first start-up of engine check for leaks.

Installation Diagrams

3 Inch (76mm) Exhaust Riser Kit 93320A6 Models With Cast Iron Elbows

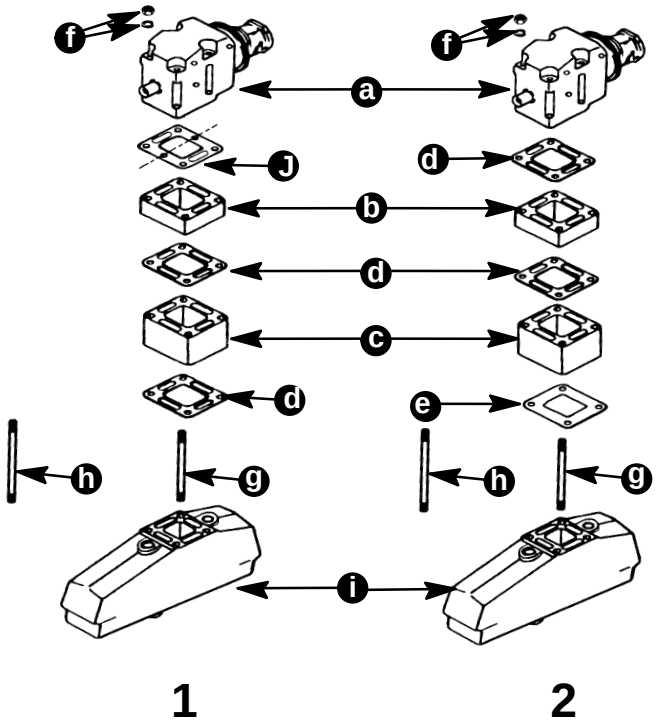


70621

Installation Without Mufflers

1 - Open Or Restrictor Gasket
2 - Separator Gasket

a - Exhaust Elbow 4 In. (101 mm)
b - Manifold Separator Gasket
c - Exhaust Riser 3 in. (76 mm)
d - Open Gasket (4 Slots)
e - Restrictor Gasket
f - Nut (8) Washer (8)
g - Stud (8) 9-3/8 In. (238 mm)
h - Stud (2) 10 3/8 In. (264mm) (Used Only At Remote Oil Filter Bracket) [If Equipped]
i - Exhaust Manifold



70622

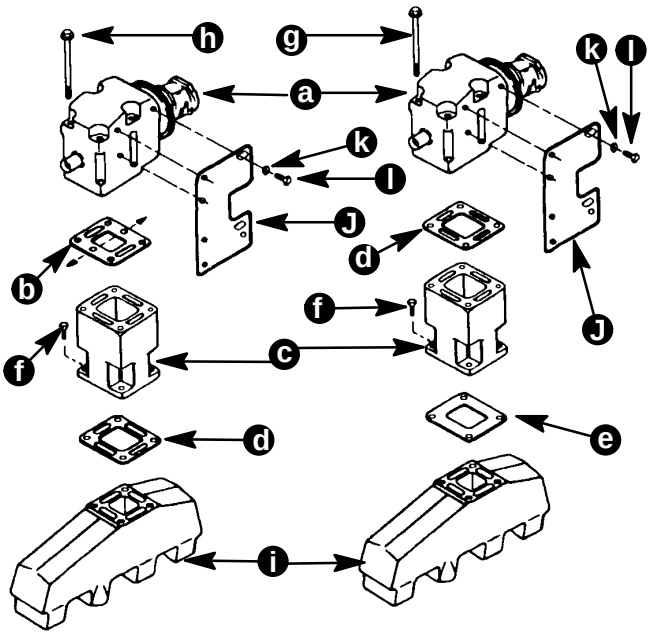
Installation With Mufflers

1 - Open Or Restrictor Gasket
2 - Separator Gasket

a - Exhaust Elbow 4 In. (101 mm)
b - Muffler Spacer 1-1/4 In (32mm)
c - Exhaust Riser 3 in. (76 mm)
d - Open Gasket (4 Slots)
e - Manifold Separator Gasket
f - Nut (8) Washer (8)
g - Stud (8) 10-7/8 In. (276 mm)
h - Stud (2) 11 7/8 In. (302mm) (Used Only At Remote Oil Filter Bracket) [If Equipped]
i - Restrictor Gasket

Index

6 Inch (152 mm) Exhaust Riser Kit 93322A4 With Cast Iron Elbows



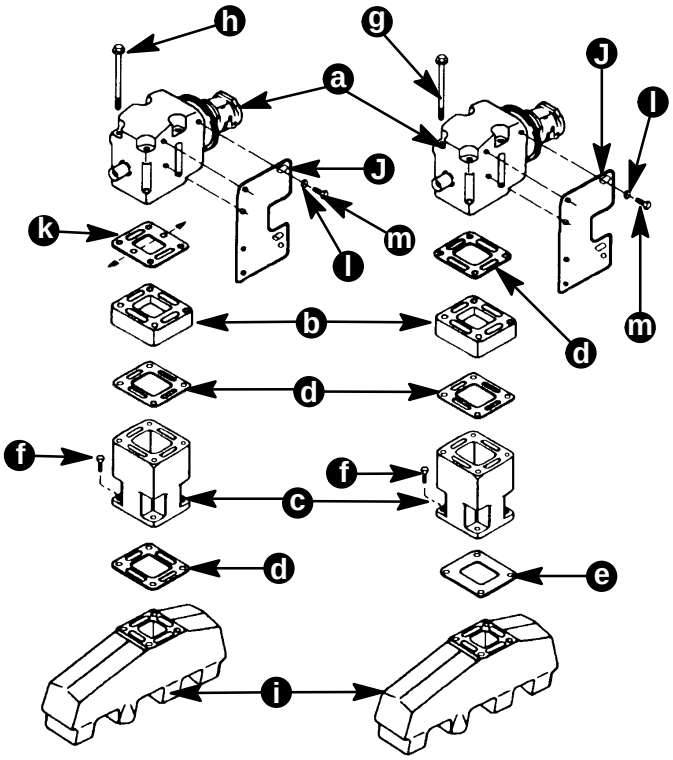
70482

1 2

Installation Without Mufflers

1 - Open Or Restrictor Gasket
2 - Separator Gasket

a - Exhaust Elbow 4 In. (101 mm)
b - Restrictor Gasket
c - Exhaust Riser 6 In. (152 mm)
d - Open Gasket (4 Slots)
e - Manifold Separator Gasket
f - Hex Head Screw (4) 1 In. (25 mm)
g - Bolt (8) 6 In. (152 mm)
h - Bolt (2) 7 In. (178 mm) (Used Only at Remote Oil Filter Bracket if Equipped)
i - Exhaust Manifold
j - Riser Bracket (1)
k - Washers (6)
l - Screws (6) 1/2 In. (12 mm)



70481

1 2

Installation With Mufflers

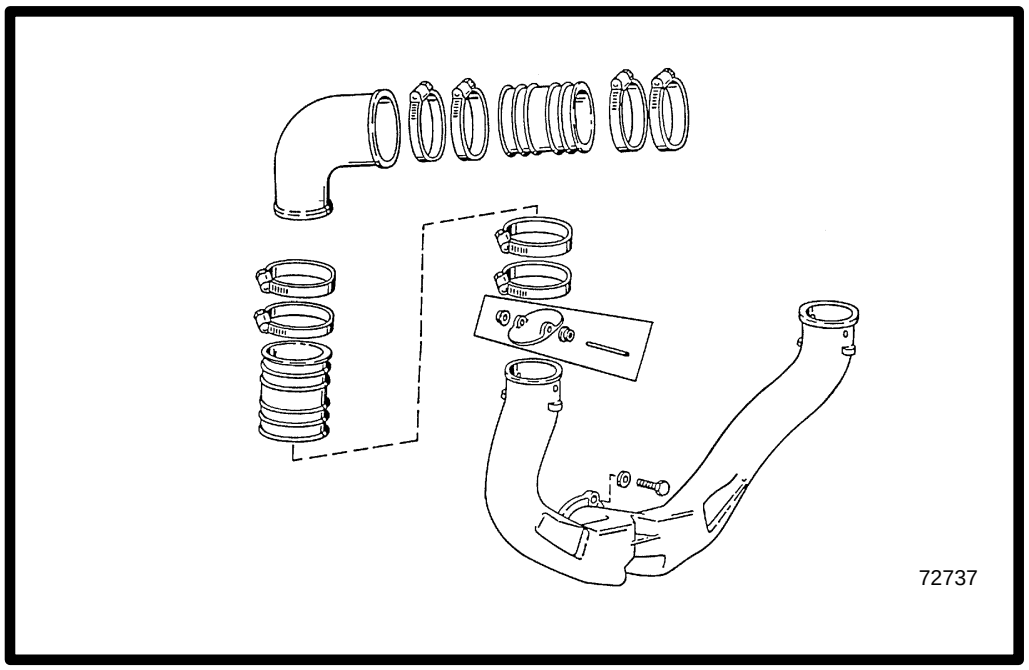
1 - Open Or Restrictor Gasket
2 - Separator Gasket

a - Exhaust Elbow 4 In. (101 mm)
b - Muffler Spacer 1-1/4 In. (32 mm)
c - Exhaust Riser 6 In. (152 mm)
d - Open Gasket (4 Slots)
e - Manifold Separator Gasket
f - Hex Head Screw (4) 1 In. (25 mm)
g - Bolt (8) 7 In. (178 mm)
h - Bolt (2) 8 In. (203 mm) (Used Only at Remote Oil Filter Bracket if So Equipped)
i - Exhaust Manifold
j - Riser Bracket (1)
k - Restrictor Gasket
l - Washers (6)
m - Screws (6) 1/2 In. (12 mm)

Index

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE

EXHAUST SYSTEM



7

D

COLLECTORS

Index

Table of Contents

	Page
Torque Specifications	7D-1
Shutter Replacement	7D-1
Component Replacement	7D-1

Index

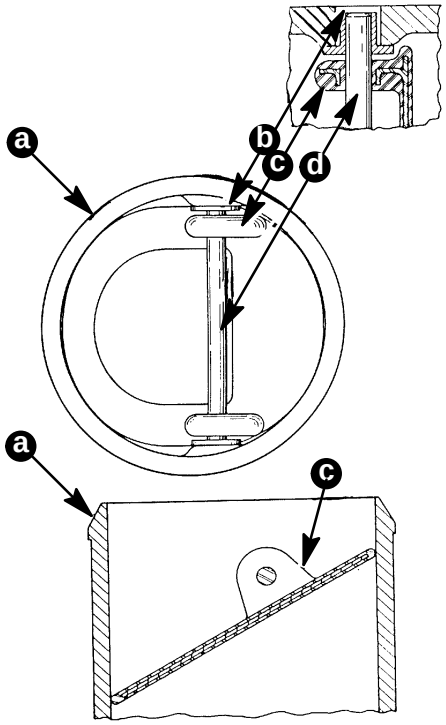
Torque Specifications

Fastener Location	Lb. Ft.	N•m
Hose Clamps	Securely	
Exhaust Elbow	20-25	27-34
Exhaust Pipe to Gimbal Housing		

Shutter Replacement

IMPORTANT: Engine does not have to be removed to change shutters.

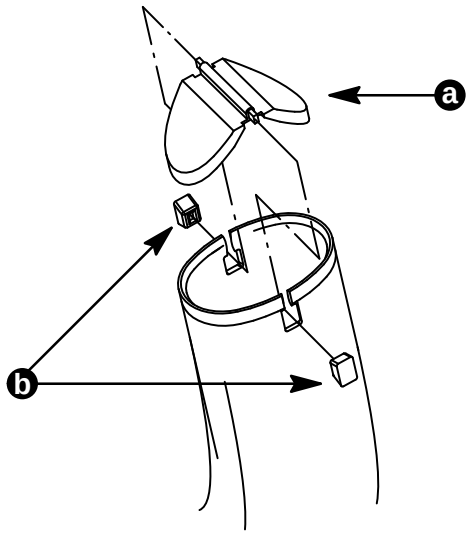
1. Loosen clamps and remove exhaust pipe elbow and exhaust hose.
2. Replace water shutter as shown.
3. Reinstall pipe elbow and hose. Tighten clamps securely.



72729

Earlier Style Shutter

a - Top of Pipe
b - Shoulder Bushing
c - Water Shutter
d - Shaft



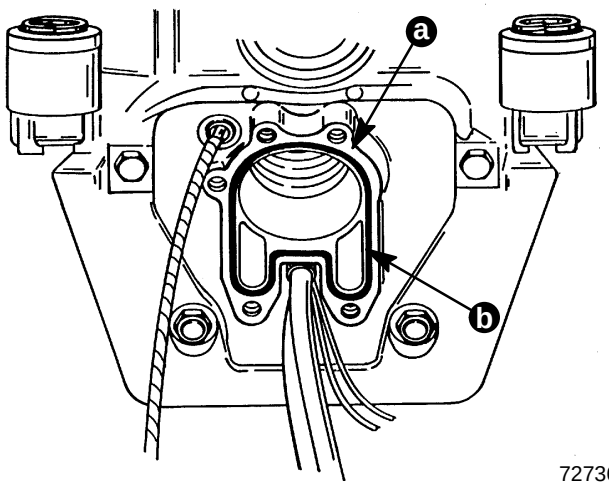
Later Style Shutter

a - Exhaust Flapper
b - Rubber Grommets

Component Replacement

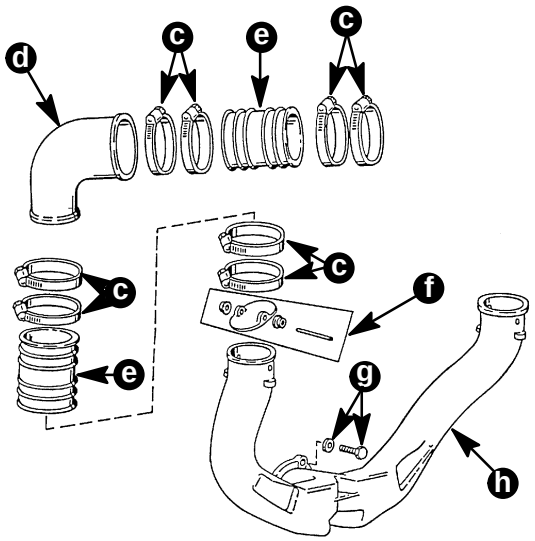
To replace any components(s) in exhaust system, the following must be adhered to:

- **All mating joint surfaces must be clean.**
- **O-ring must remain in groove to properly seal joints to prevent leakage.**
- **Torque all bolts to 20-25 lb. ft. (27-34 N•m).**
- **Tighten all clamps securely.**



72736

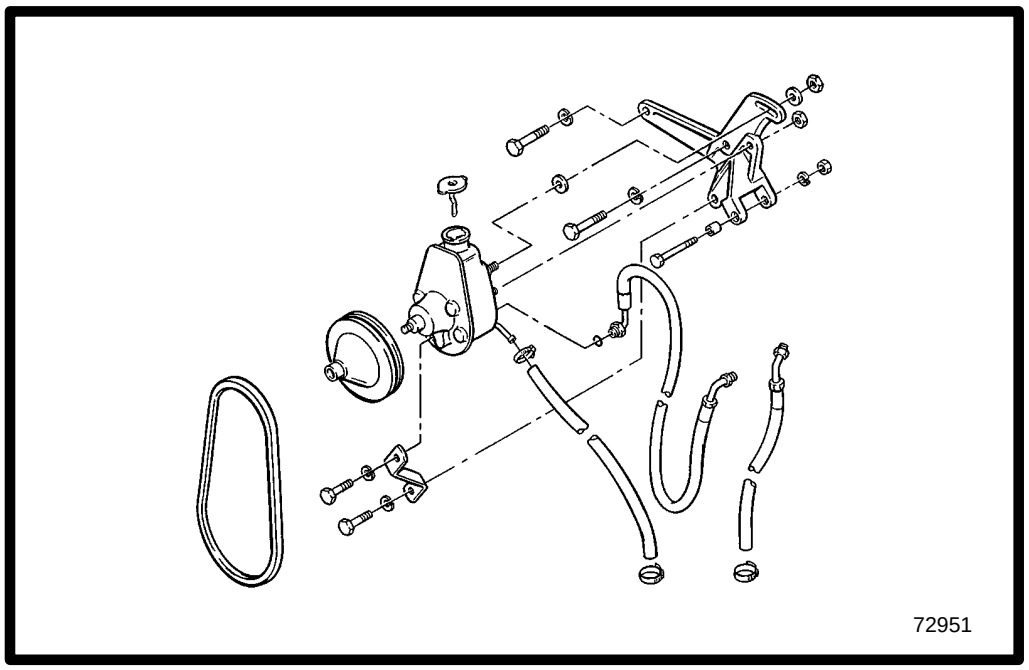
a - Mating Surface
b - O-Ring



72737

a - Mating Surface
b - O-Ring
c - Clamps
d - Exhaust Pipe Elbow
e - Exhaust Hose
f - Water Shutters
g - Bolts and Lockwashers
h - Exhaust Pipe

POWER STEERING



PUMP

8

A

Index

Table of Contents

	Page
Torque Specifications	8A-1
Tools/Sealants	8A-1
Precautions	8A-1
Power Steering Pump and Components (Exploded View)	8A-2
Serpentine Belt Routing	8A-3
Important Service Information	8A-4
Pump Pulley Replacement	8A-4
Testing and Repair	8A-5
Checking Pump Fluid Level	8A-5
Filling and Air Bleeding System	8A-5
Belt Adjustment	8A-5
V-Belt	8A-5
Serpentine Belt Adjustment	8A-5
Pump Assembly	8A-6
Mounting Bracket	8A-7
Hydraulic Hoses and Fluid Cooler	8A-7
High Pressure Hose (Pump-to-Control Valve)	8A-7
Low Pressure Hose (Cooler-to-Pump)	8A-8
Low Pressure Hose (Control Valve-to-Cooler)	8A-10
Priority Valve Kit (79691A1) Information	8A-12
Installing Reservoir	8A-12
Installing Priority Valve	8A-14
Filling System with Fluid	8A-17
Maintenance	8A-17
System Flow Diagram	8A-18

Torque Specifications

Fastener Location		Lb. Ft.	Lb. In.	N·m
Crankshaft Pulley To Torsional Damper		35		42
Torsional Damper To Crankshaft		60		81
Pump Mounting Bracket To Engine		30		41
Recirculation Pump Pulley			240	27
Early Style Power Steering Hose Fittings	Large	20-25		27-34
Early Style Power Steering Hose Fittings	Small		96-108	11-12
Later Style Power Steering Hose Fittings		23		31

Tools/Sealants

Description	Part Number
Pulley Installer	91-93656A1
Quicksilver Perfect Seal	92-34227-1
Pulley Removal Tool (Kent-Moore)	J-25034

Kent-Moore Special Tools
29784 Little Mack
Roseville, MI 48066
(313) 574-2332

Precautions

⚠CAUTION

Do not operate engine without cooling water being supplied to water pickup pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

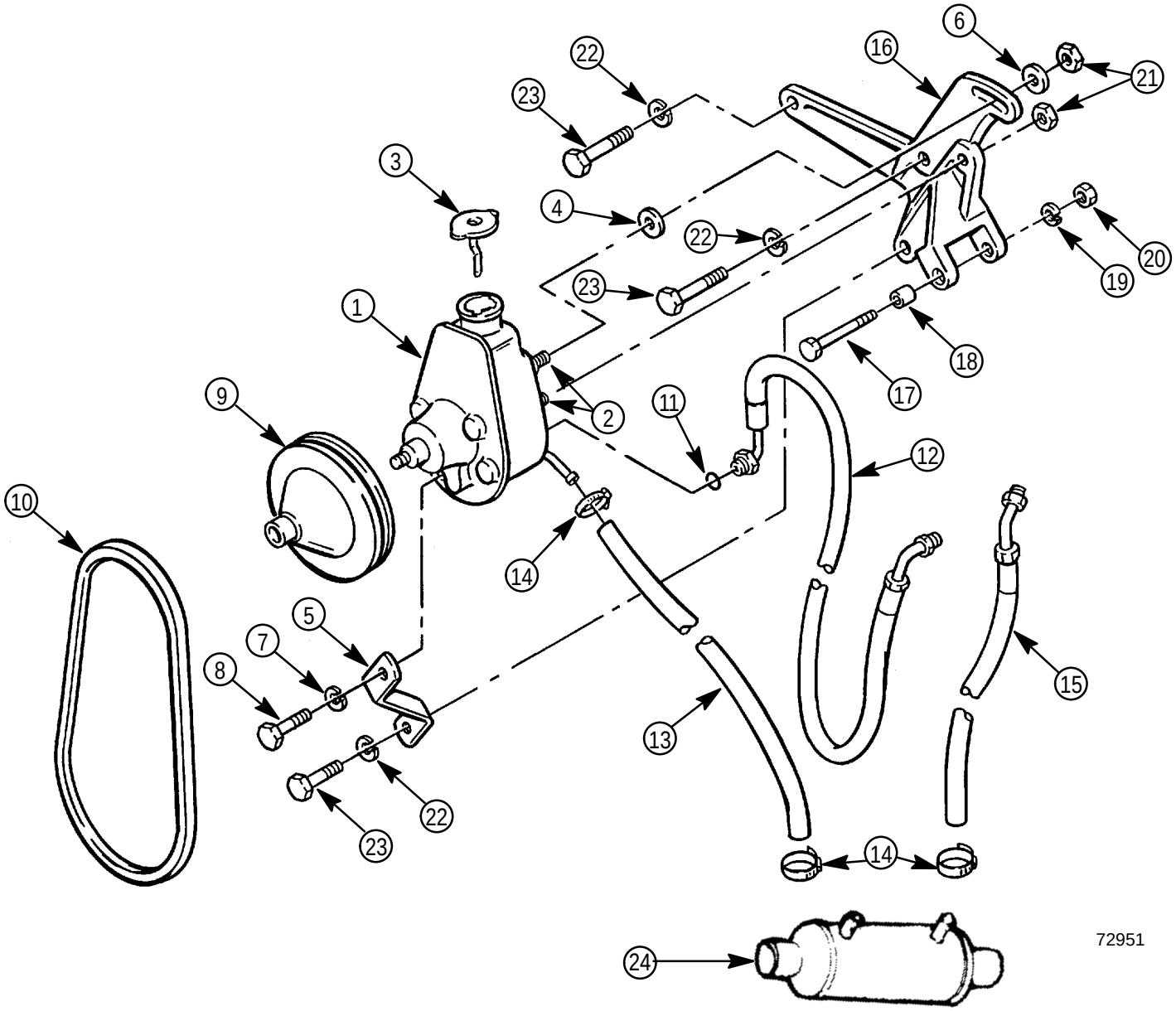
⚠WARNING

Always disconnect battery cables from battery before working on engine to prevent fire or explosion.

⚠CAUTION

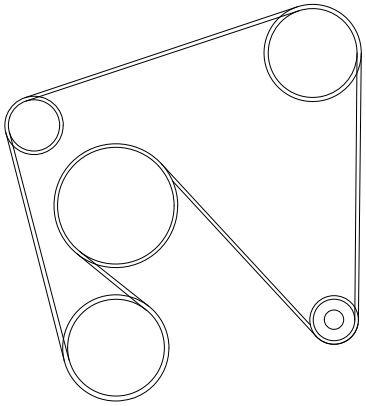
Do not pry on power steering pump or alternator when adjusting belt tension. Serious damage may result.

Power Steering Pump and Components (Exploded View)

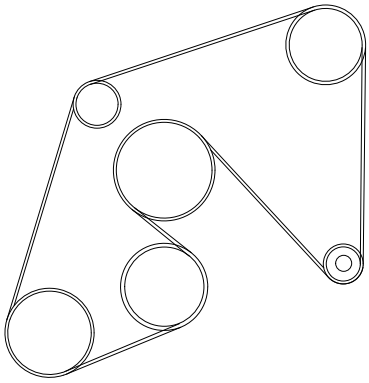


1 - Power Steering Pump Assembly
2 - Stud
3 - Cap
4 - Spacer
5 - Brace
6 - Spacer
7 - Lockwasher
8 - Bolt, Pump To Brace
9 - Pulley
10- Belt
11- O-Ring, High Pressure Hose Fitting
12- Hose, High Pressure (Fittings on Both Ends)
13- Hose, Pump To Fluid Cooler
14- Clamp
15- Hose, Control Valve To Fluid Cooler (Fitting On One End)
16- Mounting Bracket, Cast
17- Bolt
18- Spacer (Barrel Shaped)
19- Lockwasher
20- Nut (For Item 17)
21- Nut (For Item 21)
22- Lockwasher
23- Bolt To Cylinder Block
24- Power Steering Cooler

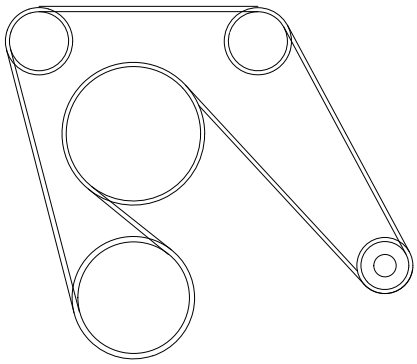
Serpentine Belt Routing



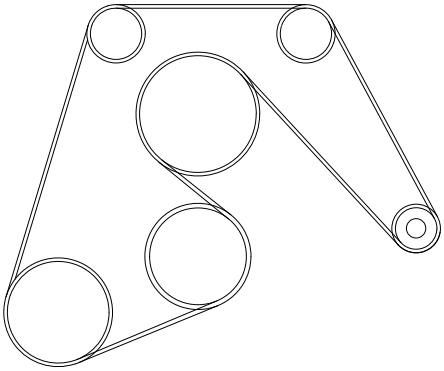
ALPHA WITH POWER STEERING



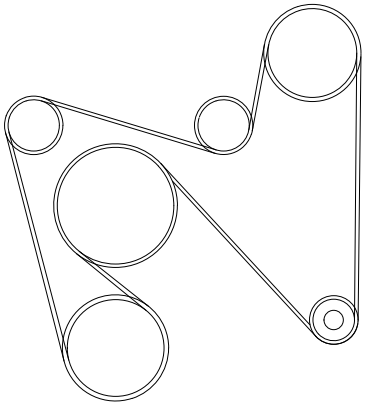
BRAVO WITH POWER STEERING



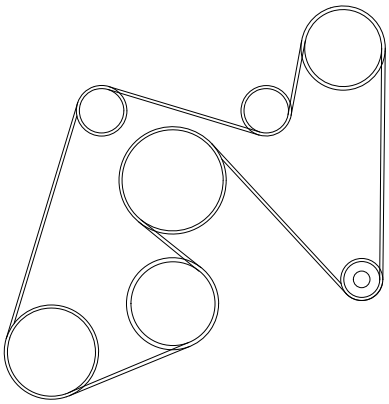
ALPHA WITH CLOSED COOLING WITHOUT POWER STEERING



BRAVO WITHOUT POWER STEERING



ALPHA WITH CLOSED COOLING AND POWER STEERING



BRAVO WITH CLOSED COOLING AND POWER STEERING

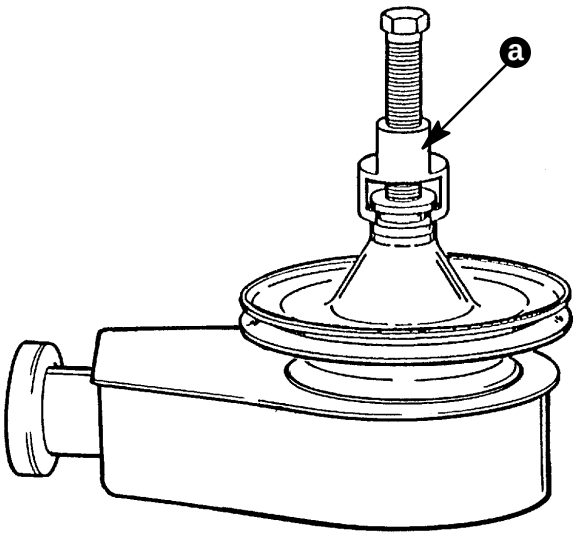
Important Service Information

Pump Pulley Replacement

REMOVAL

IMPORTANT: Kent-Moore Tool J-25034 must be used to remove the pressed-on pulleys used on power steering pumps. This tool has an end on it that will not mushroom the end of the pump shaft. DO NOT use Kent-Moore Tool J-21239 to remove these pulleys. This tool has a tapered end and will damage the shaft.

1. Install Kent-Moore Tool J-25034 on end of pulley and shaft as shown.
2. While holding tool with suitable wrench, turn threaded screw until pulley is removed.



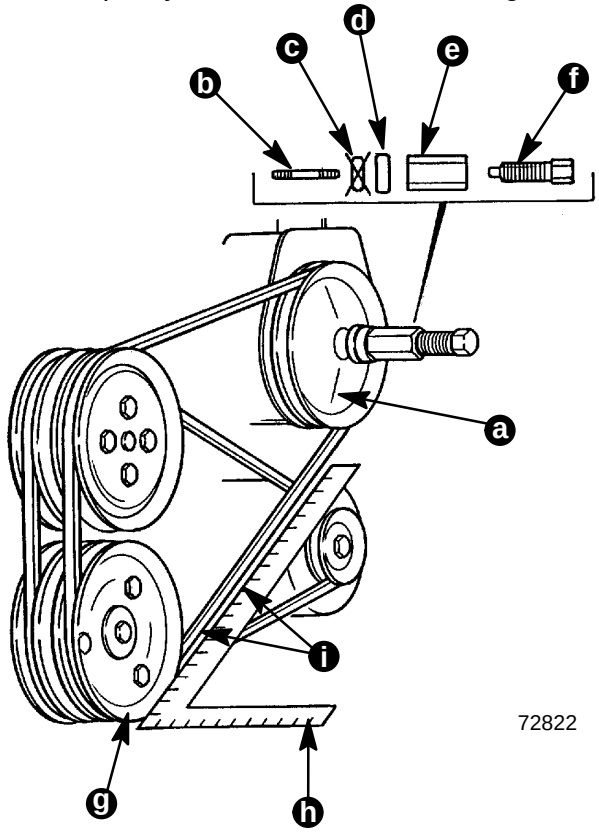
72821

a - Kent-Moore Pulley Removal Tool (J-25034)

INSTALLATION

Install pulley, as follows, using pulley installer tool (91-93656A1), and a long straight edge:

1. Place pulley on pump shaft.
2. Thread stud all the way into pump shaft. Place bearing over stud. Do not use spacer from kit.
3. Thread nut onto shaft. Thread tool shaft (and nut) all the way onto stud (threaded into pump pulley).
4. Using a long straight edge (to check drive belt alignment), turn large pusher nut until drive belt is parallel to straight edge.
5. Check pulley installation for correct alignment.



72822

a - Power Steering Pump Pulley
b - Stud
c - Do Not Use Spacer
d - Bearing
e - Nut
f - Tool Shaft
g - Crankshaft Pulley (shown) Or Water Circulating Pump Pulley
h - Long Straight Edge
i - Drive Belt Parallel

Testing and Repair

Refer to appropriate MerCruiser Stern Drive Service Manual.

Checking Pump Fluid Level

Refer to Section 1B - “Maintenance” (see “Table of Contents”).

Filling and Air Bleeding System

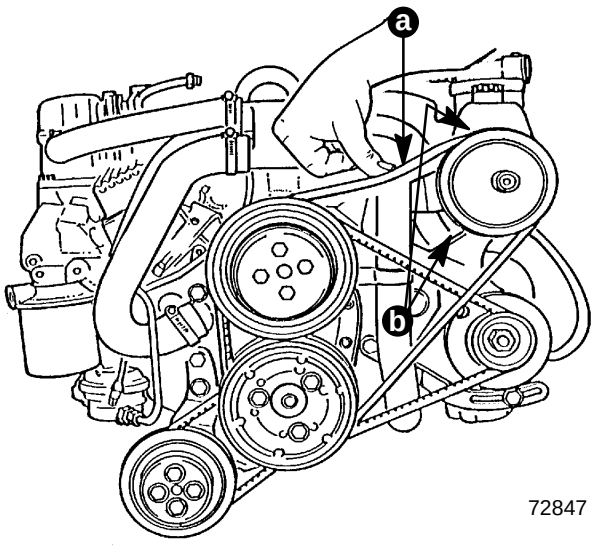
Refer to Section 1B - “Maintenance” (see “Table of Contents”).

Belt Adjustment

V-Belt

IMPORTANT: Do not pry on power steering pump with pry bar or screwdriver. Serious damage may result.

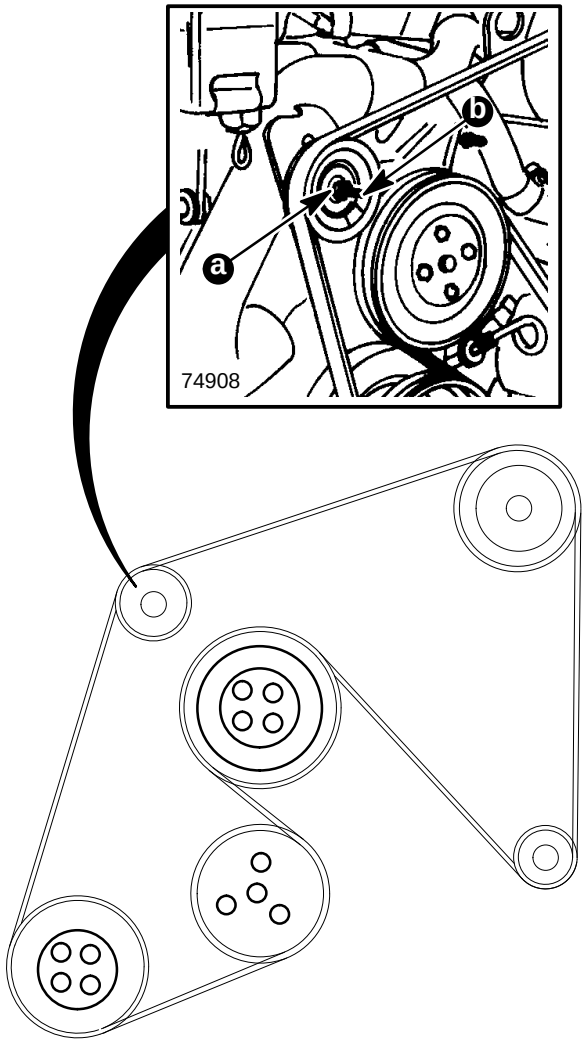
1. Install drive belt on pulleys and adjust tension as follows:
   a. Pivot pump away from engine, as required, until correct tension is obtained, as shown.
   b. After obtaining correct tension, securely tighten pump brace and pump mounting bolts.
2. If a new drive belt has been installed, recheck belt tension after running for five minutes.



a - Belt Should Depress 1/4 In (6 mm)
b - Screws and Nuts

Serpentine Belt Adjustment

1. Using a 5/8 inch wrench, loosen the nut on the adjustment stud.
2. Place the 5/16 inch deep socket on the hex end of the adjustment stud rotate starboard tensioner until there is 1/4 inch (6 mm) deflection is achieved between the pulleys with the greatest distance between them (this location may be different with various belt configurations).
3. While holding adjustment stud at the correct belt tension, tighten locking nut.



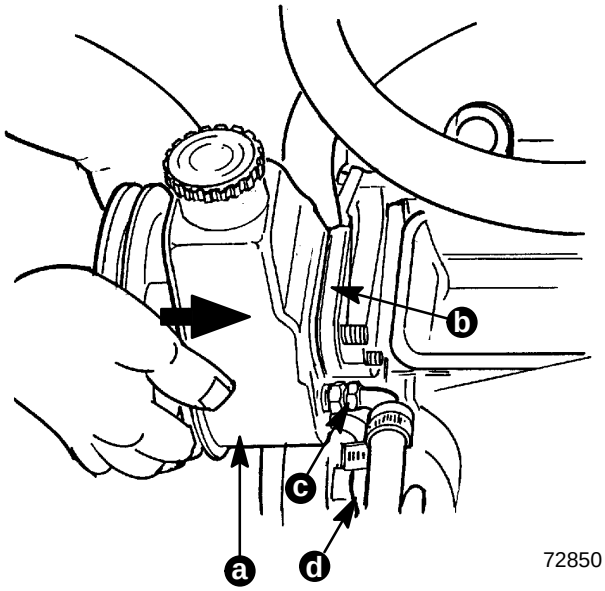
Bravo Model With Power Steering Shown (Other Configurations Will Be Different)

a - Locking Nut
b - Adjustment Stud

Pump Assembly

IMPORTANT: Be careful to not cross-thread or over-tighten hose fittings.

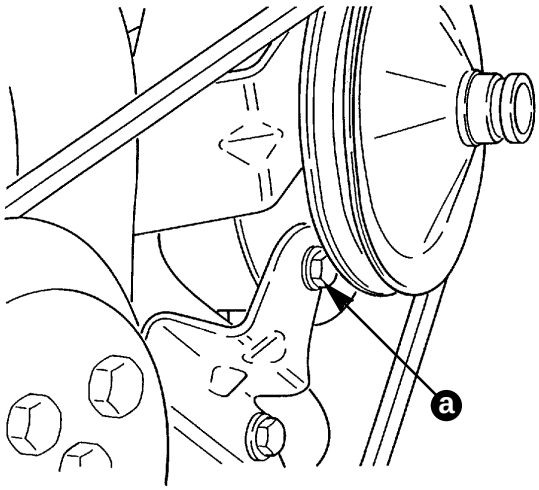
1. Be certain a new high pressure hose O-ring is present, and install threaded fitting in back of pump assembly. Tighten fitting securely. Connect low pressure hose on back of pump. Tighten hose clamp securely.



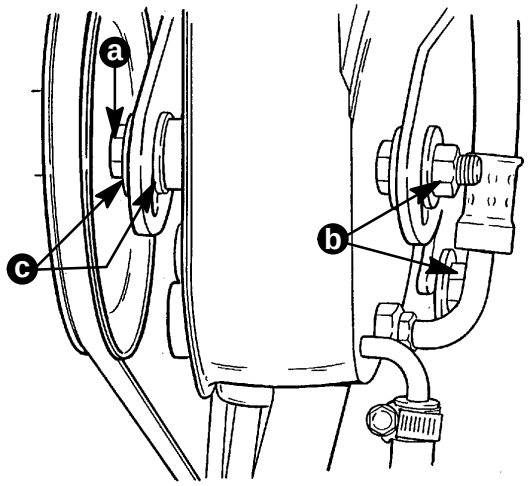
72850

a - Pump
b - Bracket
c - Threaded Fitting
d - Low Pressure Hose

2. Install mounting hardware and fasteners to retain pump to bracket. (Refer to “Exploded View” for specific details on your engine.)



72849



72848

a - Screw With :Lockwasher
b - Nuts (With Hardware)
c - Spacers

3. Install drive belt and adjust tension. Refer to “Pump Drive Belt Adjustment” as previously outlined.
4. Fill and air bleed system. Refer to Section 1B - “Maintenance” (see “Table of Contents”).

Mounting Bracket

Mounting bracket is removable after pump (refer to previous instructions) and alternator (refer to Section 4C - “Charging System”) have been removed. See “Exploded View” and “Torque Specifications.”

Hydraulic Hoses and Fluid Cooler

Refer to Section 6A - “Seawater Cooled Models” or Section 6B - “Closed Cooled Models” for information on testing or servicing power steering fluid coolers. The following is provided to assist in replacement of power steering fluid hoses and to assure proper routing and connection to the cooler.

Replace high or low pressure hoses following:

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leakage.

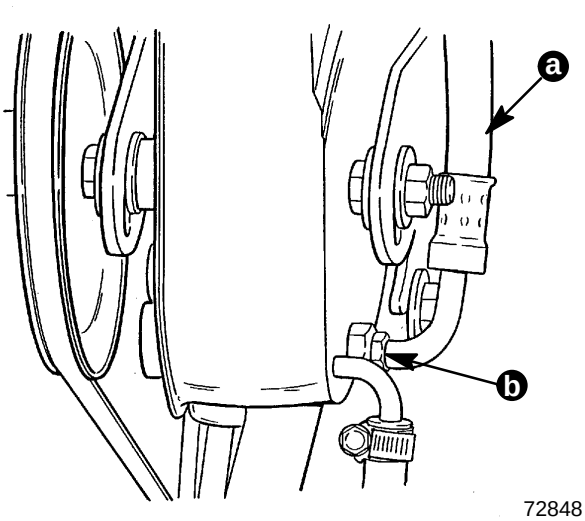
IMPORTANT: Be careful to not cross-thread or over-tighten hose fittings.

High Pressure Hose (Pump-to-Control Valve)

REMOVAL

NOTE: *Catch fluid that drains from pump and hoses in a suitable container.*

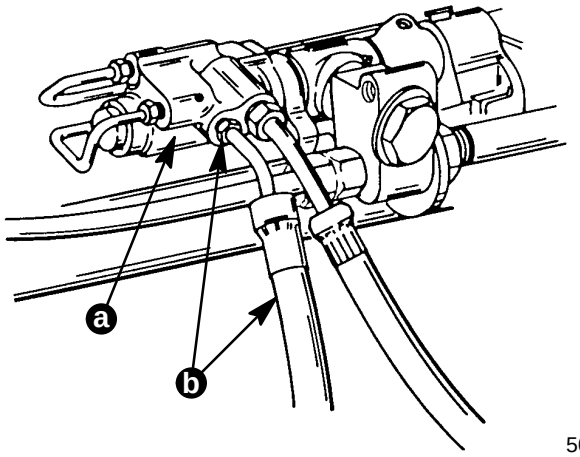
1. Remove high pressure hose fitting and O-ring seal from rear of pump.



72848

a - High Pressure Hose
b - Fitting (With O-Ring - Not Visible In This View)

2. Remove hose where routed and secured (port or starboard side), across top of engine, near valve cover.
3. Remove small fitting from control valve at transom. Remove hose.



50912

a - Control Valve
b - Small Fitting And Hose

INSTALLATION

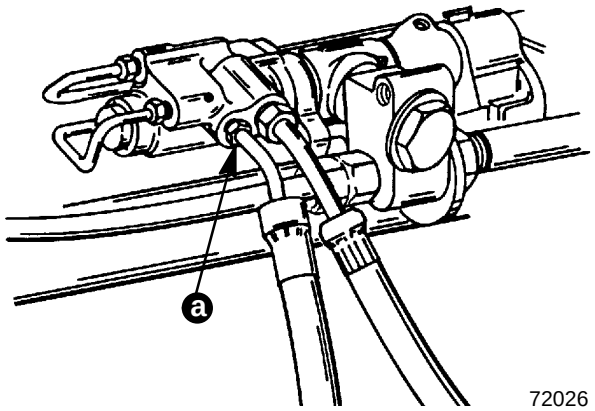
⚠CAUTION

Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hoses.

IMPORTANT: Be careful to not cross-thread or over-tighten hose fittings.

1. Thread small fitting into control valve. Position hose properly (as prior to removal).

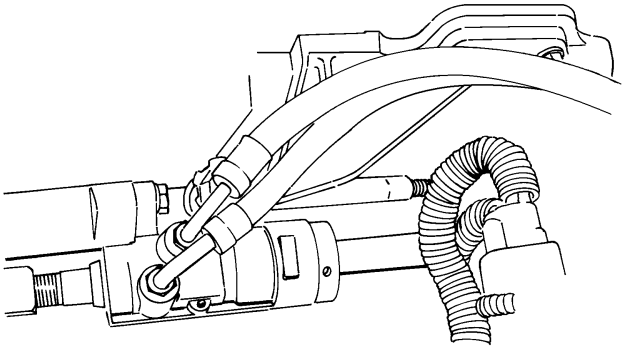
Earlier Style Control Valve: Torque small fitting to 96-108 lb. in. (11-12 N·m).



72026

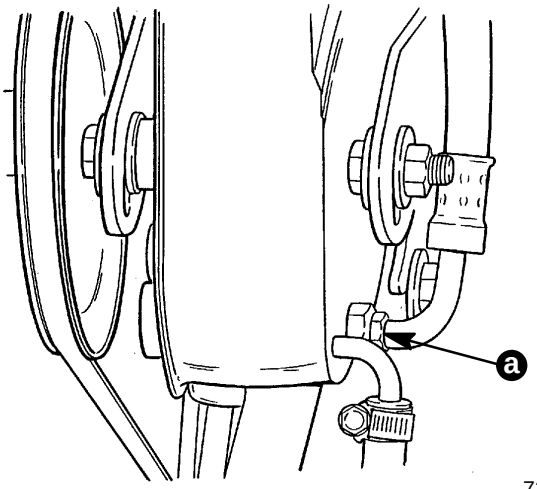
a - Small Fitting

Later Style Control Valve: Torque fittings to 23 lb. ft. (31 N·m)



73786

2. Route hose along valve cover and secure with J-clamp(s) provided.
3. Be certain a new high pressure hose O-ring is present, and install threaded fitting in back of pump assembly. Tighten fitting securely. Do not cross-thread or over-tighten.



72848

a - Fitting (With O-Ring - Not Visible In This View)

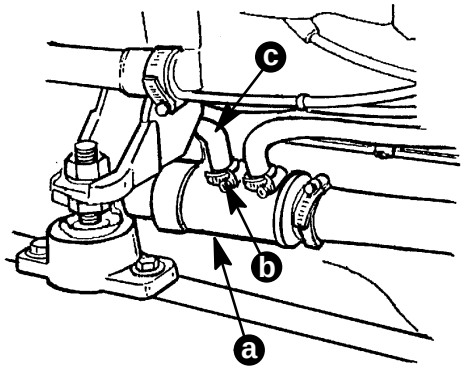
4. Fill and air bleed system. Refer to Section 1B - “Maintenance” (see “Table of Contents”).

Low Pressure Hose (Cooler-to-Pump)

REMOVAL

NOTE: Catch fluid that drains from hose, cooler and pump in a suitable container.

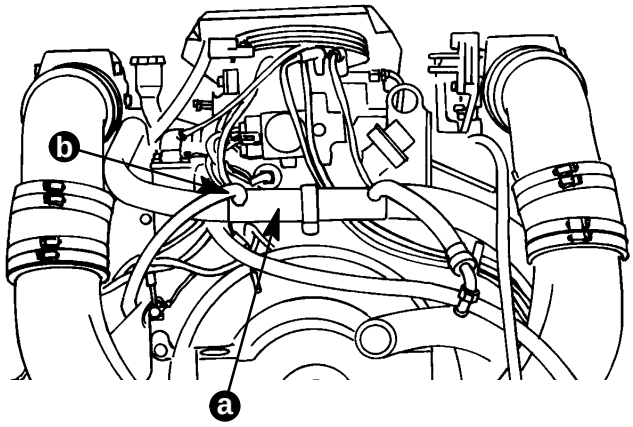
1. Loosen hose clamp and remove hose from fluid cooler.



72588

Port Side Mounted Fluid Cooler

a - Fluid Cooler
b - Hose Clamp
c - Hose

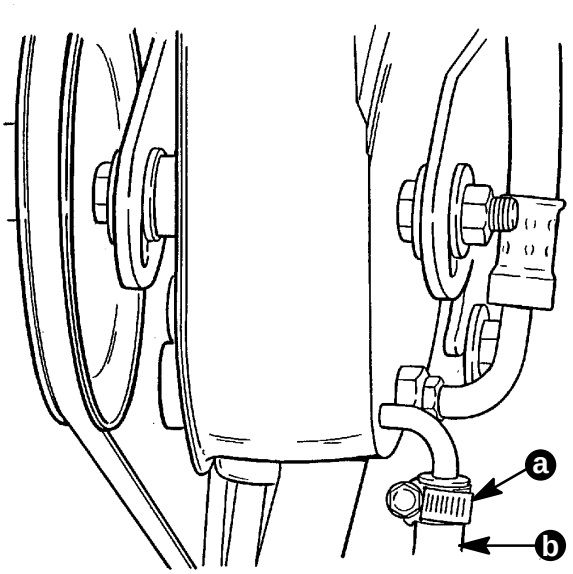


74752

Rear Mounted Fluid Cooler

a - Fluid Cooler
b - Hose

2. Loosen hose clamp and remove hose from back of pump.

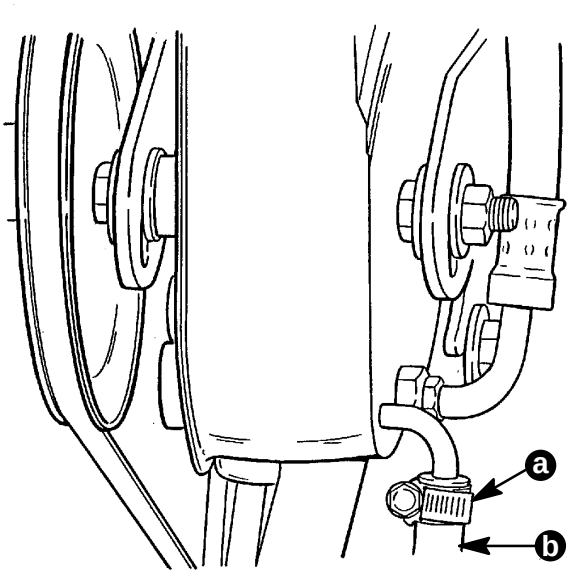


72848

a - Hose Clamp
b - Hose

INSTALLATION

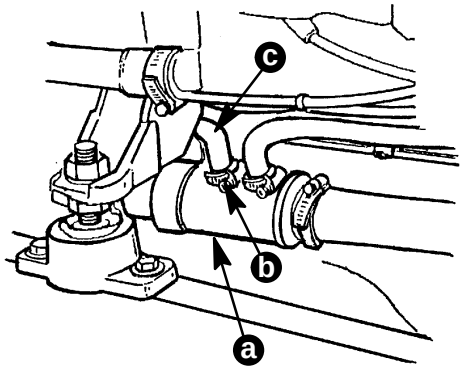
1. Using hose clamp, install new hose on back of pump. Tighten clamp securely.



72848

a - Hose Clamp
b - Hose

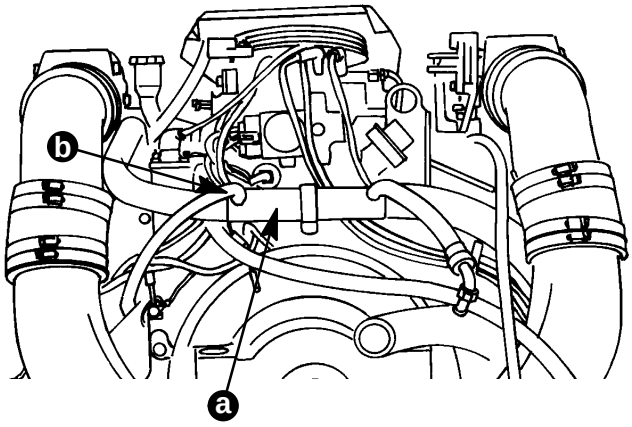
2. Using hose clamp, install hose on fluid cooler. Tighten clamp securely.



72588

Port Side Mounted Fluid Cooler

a - Fluid Cooler
b - Hose Clamp
c - Hose



74752

Rear Mounted Fluid Cooler

a - Fluid Cooler
b - Hose

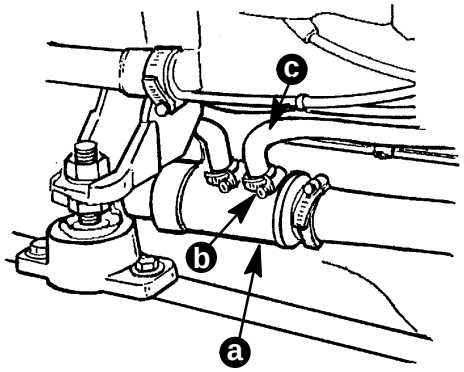
3. Fill and air bleed system. Refer to Section 1B - “Maintenance” (see “Table of Contents”).

Low Pressure Hose (Control Valve-to-Cooler)

REMOVAL

NOTE: Catch fluid that drains from hose, cooler and pump in a suitable container.

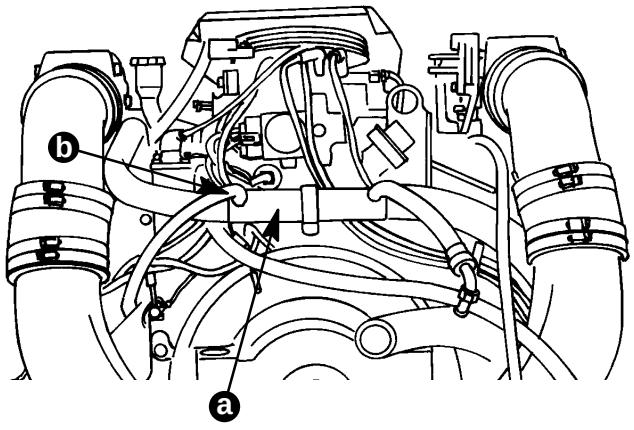
1. Loosen hose clamp and remove hose from fluid cooler.



72588

Port Side Mounted Fluid Cooler

a - Fluid Cooler
b - Hose Clamp
c - Hose

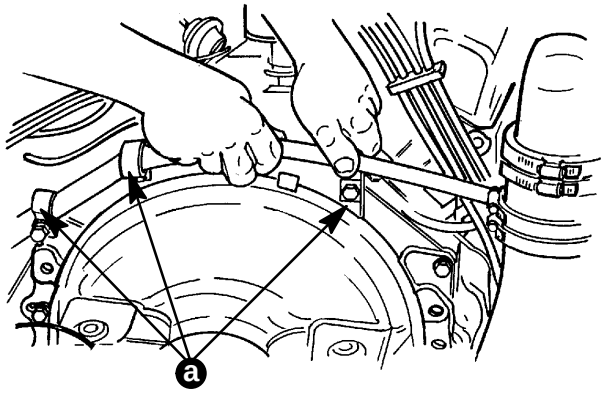


74752

Rear Mounted Fluid Cooler

a - Fluid Cooler
b - Hose

2. Remove hose where routed and secured across top of engine flywheel housing.

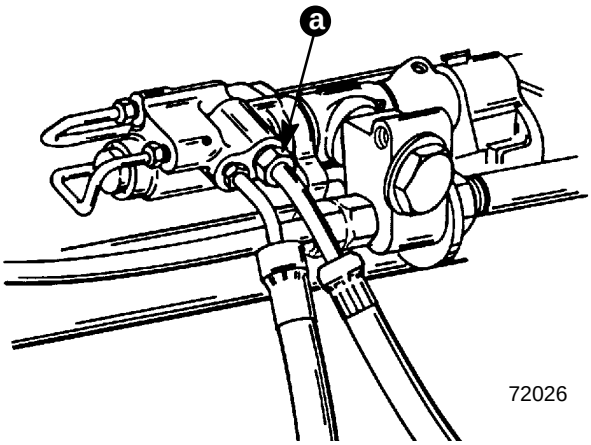


72853

Port Side Mounted Fluid Cooler Only

a - J-Clamps

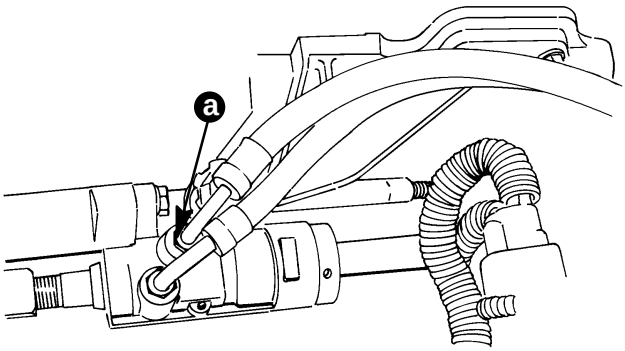
3. Remove large fitting from control valve at transom. Remove hose.



72026

Earlier Style Control Valve

a - Large Fitting



73786

Later Style Control Valve

a - Rear Fitting

INSTALLATION

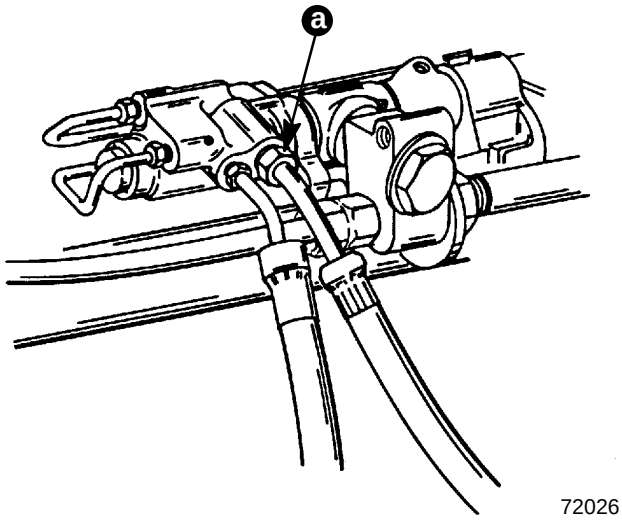
⚠CAUTION

Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hoses.

IMPORTANT: Be careful to not cross-thread or over-tighten hose fittings.

1. Thread large fitting into control valve. Position hose properly (as prior to removal).

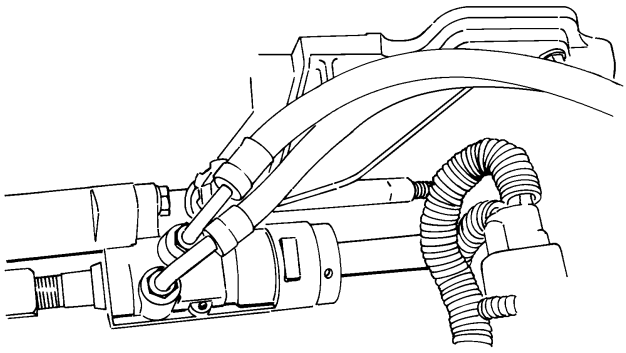
Earlier Style Control Valve: Torque large fitting to 20-25 lb. ft. (27-34 N·m).



72026

a - Large Fitting

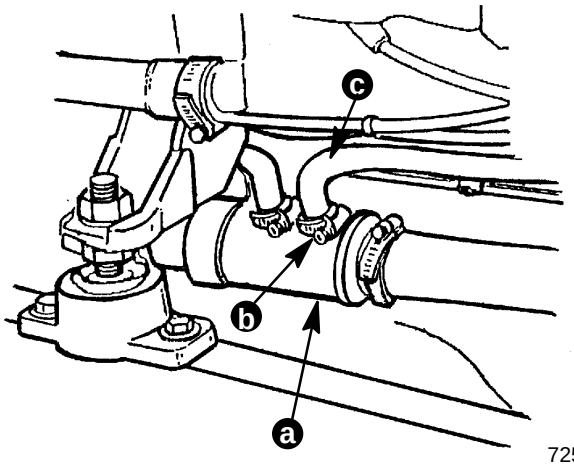
Later Style Control Valve: Torque fittings to 23 lb. ft. (31 N·m)



73786

2. Route hose along flywheel housing and secure with J-clamp(s) provided.

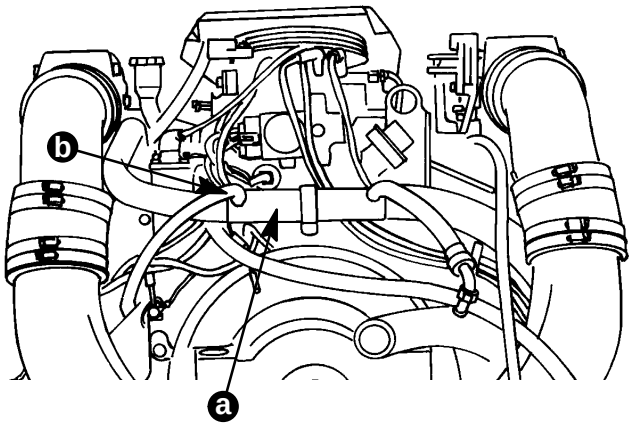
3. Using hose clamp, install hose on fluid cooler. Tighten clamp securely.



72588

Port Side Mounted Fluid Cooler

a - Fluid Cooler
b - Hose Clamp
c - Hose



74752

Rear Mounted Fluid Cooler

a - Fluid Cooler
b - Hose

4. Fill and air bleed system. Refer to Section 1B - “Maintenance” (see “Table of Contents”).

Priority Valve Kit (79691A1) Information

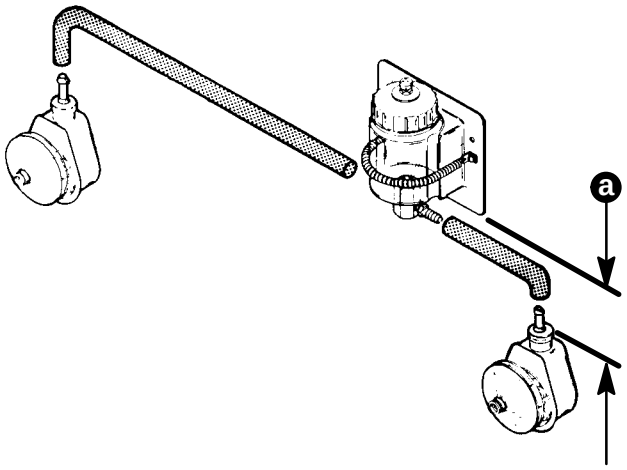
This kit information (in “Installation Instruction” form) is provided to assist personnel when servicing dual installations where both engines are equipped with power steering pumps, coolers, related hardware and hoses, and one transom assembly is equipped with power steering.

Although the system may already be installed, refer to appropriate sections and follow instructions that relate to your task when servicing those components.

NOTE: A system flow diagram is located on the last page of this section.

Installing Reservoir

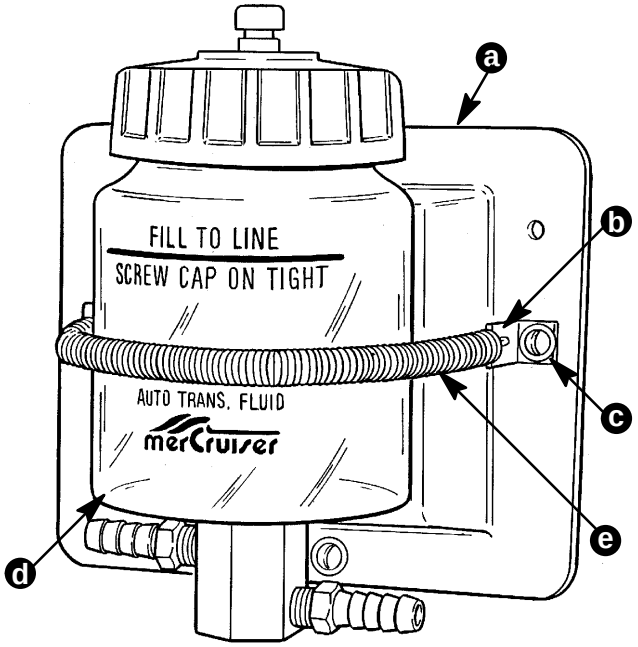
1. Mount reservoir bracket.
   a. Find a location between both power steering pumps that affords both accessibility and easy visual inspection of fluid level. Location must be at least 6 in. (152 mm) higher than pump cap to allow fluid from reservoir to flow freely to pumps (preferably on transom or on forward engine compartment wall).
   b. Install reservoir mounting bracket with hardware supplied.



71402

a - measurement - 6 Inch (152 mm) Minimum

2. Position bottle reservoir in mounting bracket and secure with retainer spring.

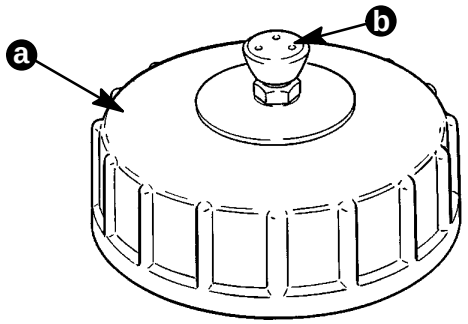


72854

a - Reservoir Bracket
b - Reservoir Spring Retainer Tab
c - Screw and Washer (Not Shown In This View)
d - Reservoir Bottle
e - Retainer Spring

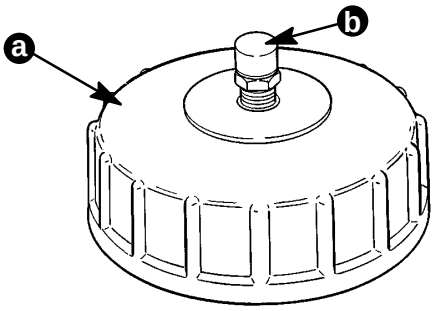
IMPORTANT: A two-way valve is required on the reservoir cap for cold weather operation below 40°F (4°C).

3. If required, install two-way valve in reservoir cap by removing vent from cover and replacing it with a two-way check valve.



72855

a - Reservoir Cap
b - Vent



72856

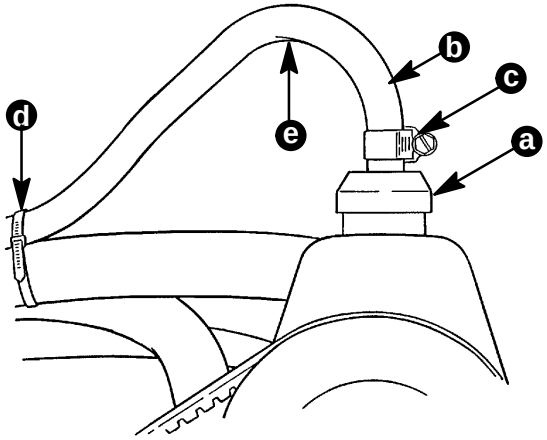
a - Reservoir Cap
b - Two-Way Valve (Installed)

4. Cut two hoses (from bulk hose supplied) of sufficient length to extend from bottom fittings on reservoir to fill caps on power steering pumps. Allow extra hose for routing.

IMPORTANT: When routing and installing hoses in the following steps, be sure that the bend radius in the hose is sufficient to eliminate a load being placed on power steering pump fill cap.

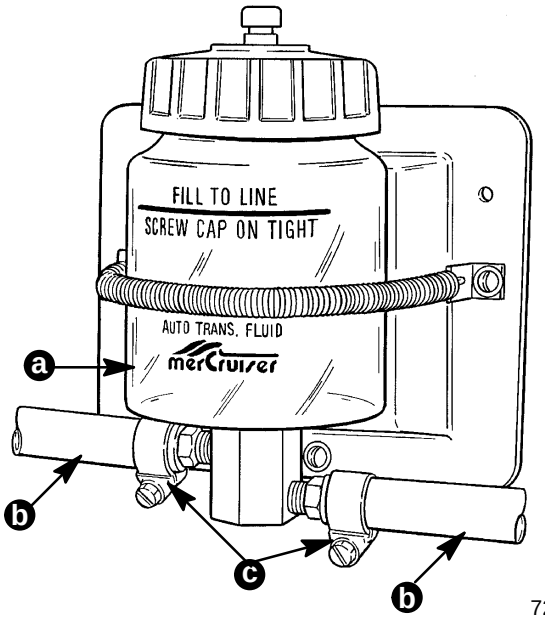
5. Connect hoses, that were just cut, to reservoir and power steering pump caps (from kit). Secure with hose clamps. Tighten securely.

6. Secure hoses with Sta-Straps to keep them below reservoir fluid level line and away from heat and moving parts.



72857

a - Power Steering Pump Cap (Port and Starboard)
b - Hose To Reservoir
c - Hose Clamp
d - Sta-Straps
e - Bend Radius (Port and Starboard)

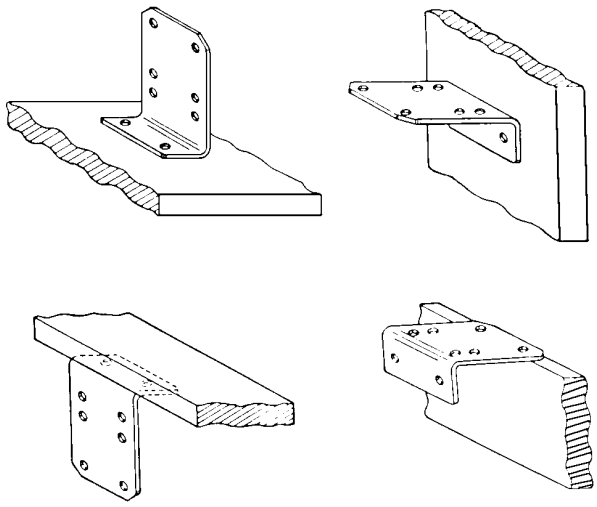


72858

a - Reservoir
b - Hoses From Pumps
c - Hose Clamps

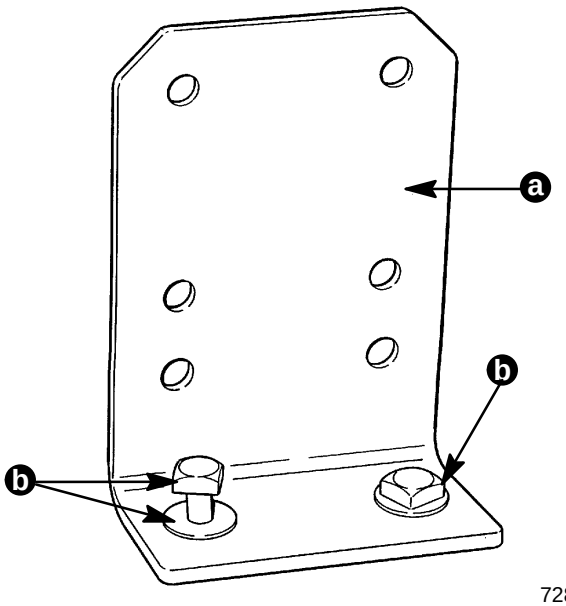
Installing Priority Valve

NOTE: Priority valve mounting bracket can be used in various mounting configurations.



71403

1. Install priority valve mounting bracket.
   a. Find a central location that will be accessible for making and checking hose connections. Ensure that location will allow 2 in. (51 mm) or more, above and below priority valve for hose connections and routing (preferably on a stringer near transom).
   b. Mount bracket using lag bolts and washers supplied.

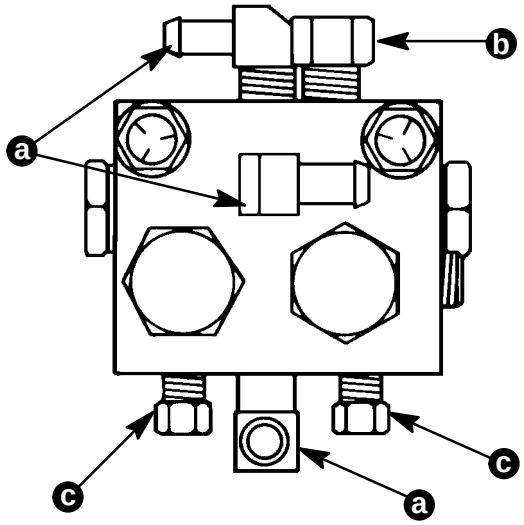


72859

a - Mounting Bracket
b - Lag Bolts and Washers

NOTE: The 90° elbow locations on priority valve are marked with a "T" stamped into the valve.

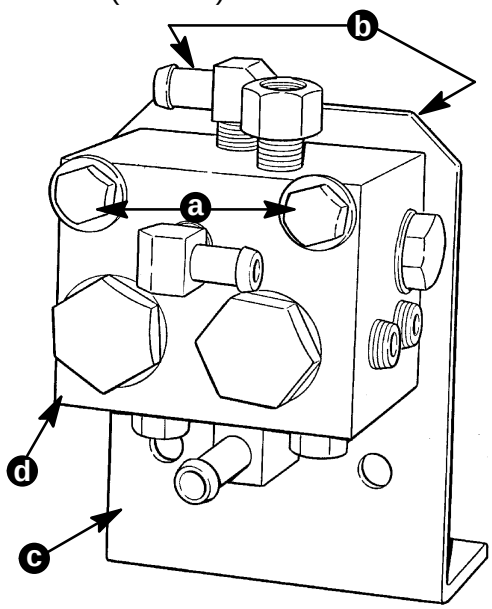
2. Apply liquid pipe joint sealer to threads and install fittings into priority valve.



71404

a - 90 Degree Elbow
b - Large Inverted Flare Fitting
c - Small Inverted Flare Fitting

3. Mount priority valve on bracket. Torque bolt to 120 lb. in. (14 N·m).

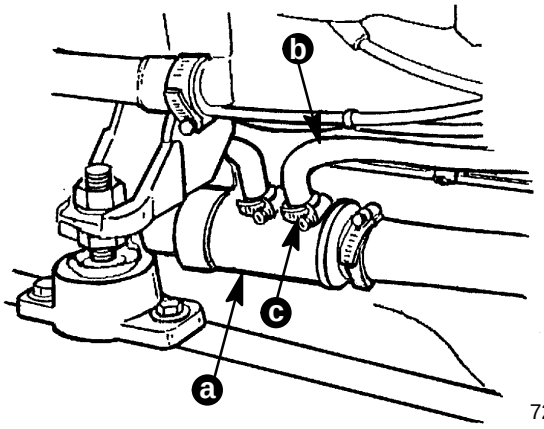


72860

a - Bolt and Washers
b - Washer and Nut (Not Shown In This View)
c - Bracket
d - Priority Valve

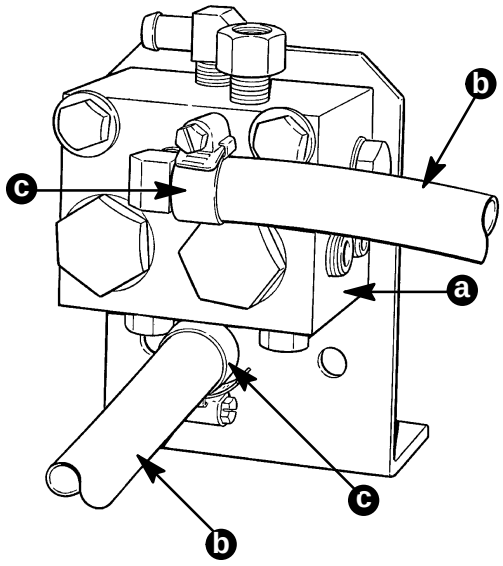
NOTE: Engines with power steering are equipped with a hose that is connected to the power steering fluid cooler. A fitting on the other end of the hose would normally be connected to the power steering control valve. These hoses are not used and are replaced with bulk hose supplied with priority valve kit.

4. Remove and discard old (control valve-to-cooler) hoses which are connected to power steering cooler (port and starboard).
5. Cut two hoses (from bulk hose supplied) of sufficient length to extend from power steering coolers to respective fittings on priority valve.
6. Connect one end of each hose to its respective power steering fluid cooler and other ends to fittings on priority valve. Secure with hose clamps. Tighten securely.



72588

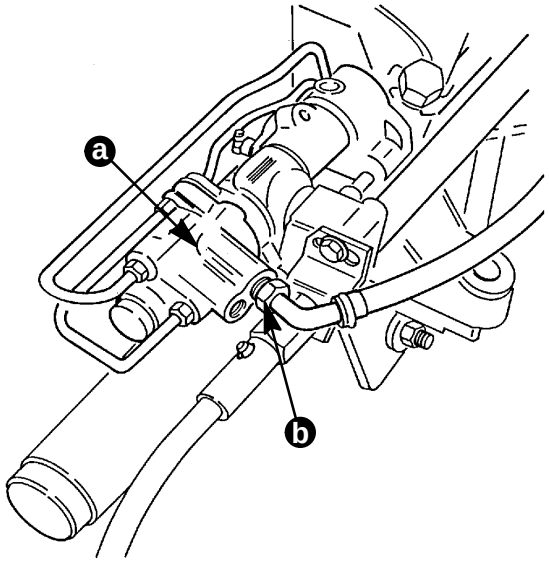
a - Power Steering Fluid Cooler
b - Hose
c - Hose Clamp



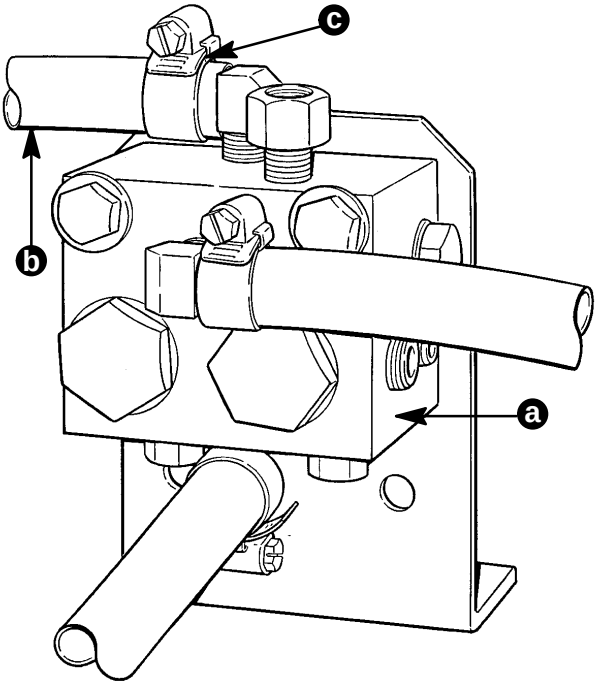
72862

a - Priority Valve
b - Hose
c - Hose Clamp

7. Install return hose (large fitting on one end only, from kit) to power steering control valve. Route hose to priority valve, cut hose to length, and connect to fitting on priority valve. Secure with hose clamp. Tighten securely.



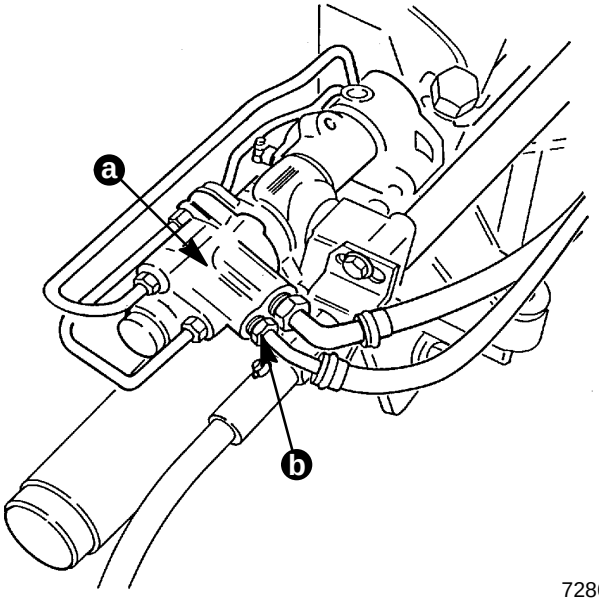
72863



72864

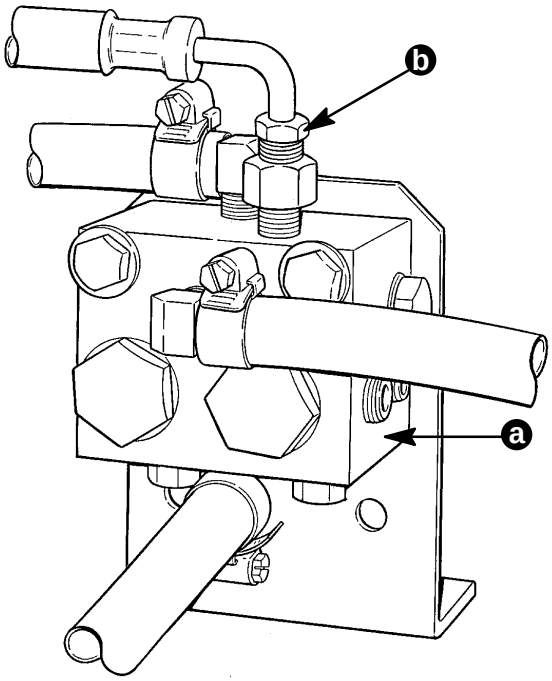
a - Priority Valve
b - Hose
c - Hose Clamp

8. Install pressure hose (fittings on both ends, from kit) between power steering control valve and large inverted flare fitting on priority valve. (This fitting location is marked with an “S.”) Secure with hose clamp. Tighten securely.



72865

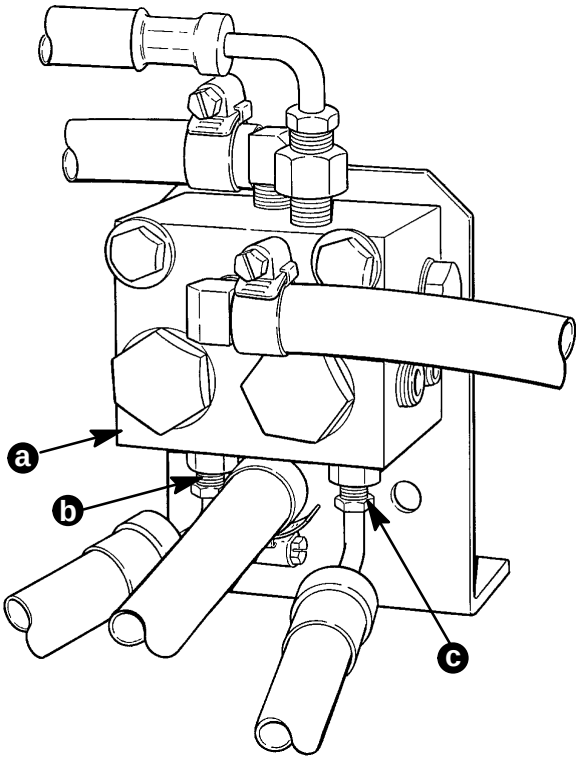
a - Power Steering Control Valve
b - Hose Fitting



72866

a - Priority Valve
b - Hose Fitting

9. Connect No. 1 (starboard) engine pressure hose (from pump) to inverted flare fitting marked by “1” on priority valve. Connect No. 2 (port) pressure hose (from pump) to inverted flare fitting marked by “2” on priority valve. Secure with hose clamps. Tighten securely.



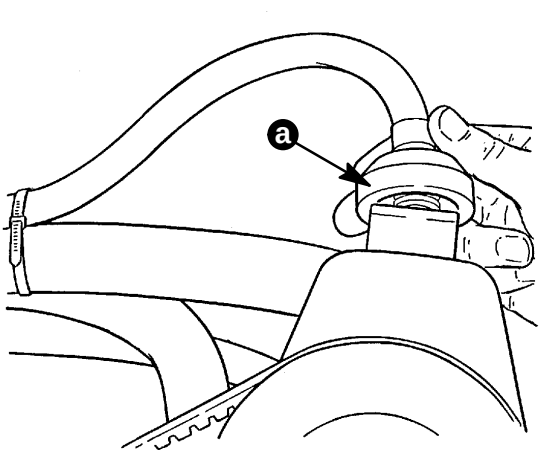
72867

a - Priority Valve
b - No. 1 (Starboard) Pressure Hose
c - No. 2 (Port) Pressure Hose

10. Secure all hoses with Sta-Straps provided.

Filling System with Fluid

1. Fill pump reservoirs with automatic transmission fluid (ATF) Dexron ll or Dexron lll.
2. Install and tighten pump cap by turning cap clockwise approximately 120 degrees.



72868

a - Cap

3. Fill reservoir bottle to full mark, then (one at a time) slightly loosen pump cap to allow fluid to flow from reservoir to pump until pump just starts to overflow, then quickly tighten pump cap. Fill bottle reservoir and repeat this process for the other pump.
4. Double check both caps to ensure they are both tight.

Maintenance

Maintenance inspection is the owner's responsibility and must be performed at the following intervals:

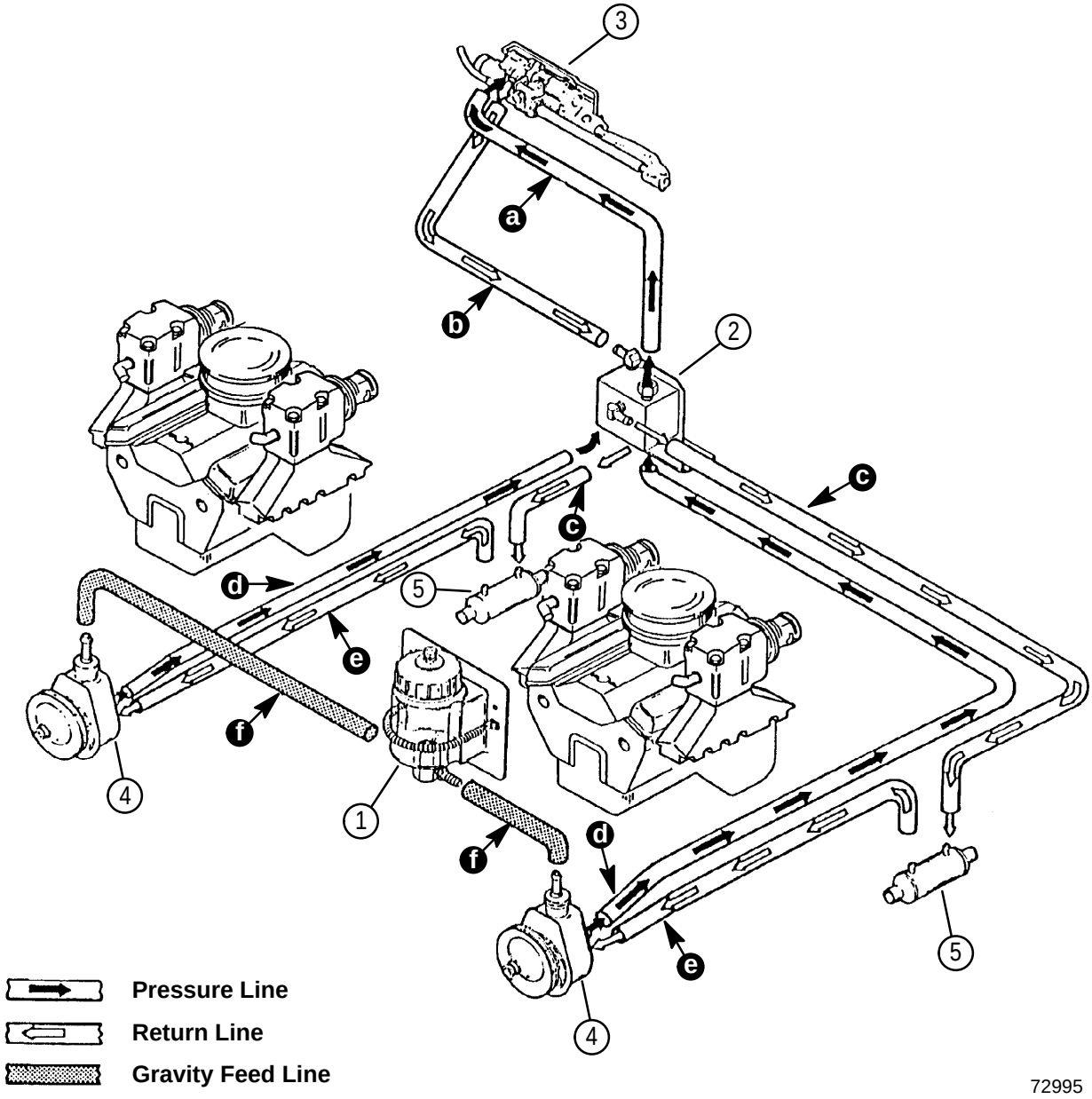
Normal Service - Every 50 hrs. of operation or 60 days (whichever comes first)

Severe Service - Every 25 hrs. of operation or 30 days (whichever comes first)

NOTE: Operation in salt water is considered severe service.

1. Check all connections and hose clamps for adequate tightness. Tighten, if loose.
2. Check all mounting bolts and tighten if necessary.
3. Be sure to check reservoir oil level periodically.

System Flow Diagram



1 - Reservoir Bottle and Bracket
2 - Priority Valve and Mounting Bracket
3 - Power Steering Control Valve
4 - Power Steering Pump
5 - Power Steering Fluid Cooler

a - Pressure Hose (Fitting On Both Ends - Supplied In Kit)
b - Return Hose (Fitting On One End - Supplied In Kit)
c - Return Hose From Pump (Cut From Bulk Hose Supplied)
d - Pressure Hose From Pump
e - Return Hose From Pump
f - Gravity Feed Hose (Cut From Bulk Hose Supplied)

THIS PAGE IS INTENTIONALLY BLANK TO ALLOW FOR CORRECTIONS OR ADDITIONS AT A LATER DATE